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Datum ex ædibus Collegii nostri
Augusti 29. A. D. 1690.



Nov: 1870.
OSTEOLOGIA NOVA:

OR, SOME
NEW OBSERVATIONS
OF THE

BONES,

AND THE
PARTS belonging to them;

WITH THE
Manner of their ACCRETION and NUTRITION:

Communicated to the ROYAL SOCIETY in
Several DISCOURSES.

I. Of the MEMBRANE, NATURE, CONSTITUENT Parts, and INTERNAL Structure of the BONES.

II. Of ACCRETION and NUTRITION; as also of the AFFECTIONS of the Bones in the *Rickets*, and of VENEREAL Nodes.

III. Of the MEDULLA, or MARROW.

IV. Of the MUCILAGINOUS Glands; with the Etiology or Explication of the CAUSES of a Rheumatism and the Gout; and the MANNER how they are produced.

To which is added,

A FIFTH Discourse, Of the CARTILAGES.

The SECOND Edition.

By CLOPTON HAVERS, M. D.
late Fellow of the Royal Society.

L O N D O N:

Printed for W. INNYS, Printer to the ROYAL SOCIETY, at the West-End of St. Paul's.

M DCC XXIX.





TO THE
Right Honourable
THOMAS
EARL of *Pembroke,*
PRESIDENT
OF THE
Royal Society.

MY LORD,



Though Ambition is one thing that carries me to address my self to a Person of your Honour and Ingenuity; yet there is a more common Principle of self-preservation, which concurs, and directs me to

The Epistle Dedicatory.

seek that Patronage which will bespeak not only the Justice, but the Candour of every Reader. And seeing the Royal Society have so great a sense of their happiness, when they are to act under the influence and conduct of so Wise and Honourable a President, I cannot question my own safety under the name of so great a Patron. When I reflect upon my self, that am a tender and an infantile Author, I find nothing but fear and discouragement, as I am in danger of being Overlaid by every little Censure: but when I consider my self under the Umbrage of a Person, whose Example and Authority may prevail with the World to be generous, and to imitate those Vertues which they so much admire in your Lordship, this frees me from that diffidence and timorous concern which the censorious temper of the Age, and the sense of my own weakness are apt to create.

But although it may reasonably be thought, and I have confess'd, that I now design my own safety, that this Treatise carries your Lordship's name as an Amulet against those censures

The Epistle Dedicatory.

censures which I expose it to ; yet it will at the same time appear to be my duty to present to your Lordship that, which the Relation you bear to the Royal Society, gives you a Title to. I do therefore humbly offer and dedicate these Discourses to your Lordship as a testimony of that profound respect which is due to a Person of your Quality and extraordinary Character ; and it is certain, that every Member of the Society speaks the Sense of the whole, when he expresses the greatest deference to your Honour.

Having therefore consulted my Duty, as well as my Interest in this thing, I hope there is no one will think my addresses a rude transgression of the Laws of Decency. I must confess, that these Discourses are too mean and unpolish'd to deserve your Lordship's Patronage ; but since the Desires of the Society did encourage my design to publish them, this seems not only to make them capable of it, but to bless them with a Title to it. I do therefore presume humbly to beg they may not offer themselves to the World without the

The Epistle Dedicatory.

advantage of your Favour, which will render them more acceptable, and gratify to the utmost the ambitious desires of,

My Lord,

Your Lordship's most humble,

and most obedient Servant,

Clopton Havers.

To



To the most Worthy

**Dr. RICHARD
MORTON,**

F E L L O W

O F T H E

College of Physicians.

SIR,

I Have been a long time obliged by a continued series of your Favours, and such as would naturally and irresistibly suggest the thoughts of gratitude to any one, that has not debauched those Principles of Reason and Justice, which are common to all Men: and I cannot

not with any satisfaction live involved in so great a Debt without an attempt to make some grateful returns. And when I have this opportunity to make a publick acknowledgment of those Obligations, by which I have plainly lost the Title I had to my self, and come under your commands, I dare not be guilty of that silence, by which I must seem either insensible, and no Man, or ungrateful, and the worst of Men. I must own it as one of the kindest Providences of Heav'n, that I had the happiness, Sir, not only to be directed in my Studies by you, but by your particular favour to enjoy many other great and extraordinary advantages; to all which under the Almighty God I owe what I may pretend to in Physick. I do therefore, as an expression of that Respect and Gratitude which are due from me, humbly present you with these Discourses:

courses: and although I shall never be able to satisfy that Debt which I have contracted; yet this will be a demonstration of my inclinations; to be Just and Grateful. And there is no one can be insensible how far I am in Justice bound to render to you that, which is an account of the Talent, which you, Sir, have intrusted me with, and so far as I am capable, taught me to improve.

What entertainment these Discourses will find in the World, I know not. I cannot have so foolish an opinion of my self, or them, as to think they are free from those imperfections which will betray the weakness of their Author; and perhaps there are some things, which Candor it self cannot overlook. However, the security I shall have from your Patronage, gives me the prospect of a more kind and candid reception, than they can deserve: which,

which, I must igenuously acknowledge, carries so much of an obligation in it, that whilst I am endeavouring to discharge one Duty, I am sensible, I contract a fresh Debt. Thus, in the very expressions of my Devotion to your service, I meet with Arguments, which confirm my resolutions, to be,

Sir,

Your most humble,

and faithful servant,

Clopton Havers.

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THE FIRST
DISCOURSE,
CONCERNING THE
MEMBRANE, the NATURE,
CONSTITUENT PARTS,
AND
INTERNAL STRUCTURE
OF THE
BONES.



INTRODUCTION.



S no Faculty has received greater Additions to its Improvement in this last Age, than Physick, so no part of that has been more tempting, or more successfully pursued than Anatomy. The Dissections of many preceding Ages
B turn'd

turn'd to a small account; so that many of the most admirable Contrivances of Nature, and of the greatest Wonders in the lesser World, were inobserv'd; till the Curiosity of some ingenious Men, animated with the hopes of some new Discoveries, put them upon farther Enquiries; in which their Industry and Felicity carried them so far, that the Existence of some parts before unknown, the Nature, Structure and Use of others, began to appear. But although the Scrutiny and Observations of our Age about some of the Parts have been very accurate, we have been only coasting about others; particularly, about the internal Fabrick, and some other things of the Bones our Searchers have been careless, our Notice slight and transient: not but that they deserve our strictest Enquiry and serious Remarks; for I do not see but the Almighty Architect has equally demonstrated his Divine Skill in the whole structure of these Parts which he has made of grosser Matter, as in the Formation of those which consist of sifted and more refined Particles. And how curious the Hand of Heaven has been in the Framing and Ordering of this Timber-work of our Bodies, may perhaps appear a little from this Discourse. A little, I say, because I am too sensible, that after all my endeavours, to act both the Philosopher and the Anatomist,

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I am infinitely unjust to my Argument; however, what I have observ'd, it is both my Duty and my present Design to communicate to this Honourable Society. And as there are several things will occur which deserve and require a Philosophical Solution, so I shall endeavour to account for them by explaining the manner in which they are produced, or considering the Reasons why Nature has ordained them, as I shall have occasion,

In speaking to this Argument, I shall purposely omit the notice of the different Figures of the Bones, the diverse manner of their Conjunction, and what has been commonly observ'd. And that I may present you with a Scheme of those general Heads which I design to treat of, they shall be these which follow:

First, The Periosteum, or that Membrane which invests the Bones; which being inservient to several ends, I shall consider the Use of.

Secondly, The Bones themselves; where I shall endeavour to give an account of their Nature, their Constituent Parts, Internal Structure, and the Pores and Passages which are formed in them; as also of those Blood-Vessels which serve for their Accretion and

Nutrition. And as the Teeth are a sort of Bones different from all others, I shall add some particular Remarks concerning them.

Thirdly, I intend to explain the manner how Accretion and Nutrition are performed, first in general, and then particularly, with respect to those Parts which are our present Subject. And in treating of these great Affairs of Nature, I shall take occasion to make some digression about the manner of Glandular Secretion; concluding this Head with the Etiology of those symptoms in the Rickets where the Bones are concerned, and Venereal Nodes.

Fourthly, I am to give an account of the Observations which I have made of the Marrow, and to describe the Blood-Vessels thereunto belonging; which when I have done, I design to consider the Use of this Oleaginous Substance.

Fifthly, I have a particular sort of Glands to give an account of, which I have observ'd in all the Joints. I shall describe the Structure and Situation of the most considerable of them, and then enquire into the Nature and Use of that Liquor which is separated by them. And because the Observation of these
Glands

Glands will be very serviceable to us in explaining the Cause of a Distemper or two that affect the Parts in which they are seated, I shall say something concerning those Distempers; which will be, first, a Rheumatism, and secondly, the Gout.

Sixthly, and lastly, I shall conclude my Discourses with an account of the Cartilages; explaining their Nature, describing their Membrane and their Structure, and enquiring into the Use, particularly of those which are united to the true Ribs.





The MANNER of GENERATION.



T may perhaps be thought reasonable and methodical by some, to begin my Discourse with the Original of my Argument, and to offer something concerning the manner, how the parts, of which I am to Treat, are first formed: and altho' the manner of an Animal's formation, whether it be generated in the Womb, or out of it, is one of the great *Arcana's* of Nature, and that which neither our Senses can observe, nor any thing of Art or Mechanism imitate; yet we may make our conjectures, and find out some probable and rational Hypothesis for our satisfaction.

The Antients, for want of those discoveries which since their time have been made, had a Notion that the *Semen* of the Man was a part of the Conception: that the Woman had a true Seed, and a composition arising from the mixture of the Seed of the Male and Female, was the material cause of the Bones, as of all other

other parts, which they termed Spermatick. But *de Graef* has better informed us, and taught us to explode that Opinion; so that it neither admits of a Defence, nor needs a Refutation, since he has discover'd to us Nests of Eggs in Viviparous Animals, and that in the Bellies of Women.

The Origin therefore, even of the highest Animal, being from an Egg, it may perhaps, if duly consider'd, seem most probable, that the Bones, and all other parts, are by the admirable Stenography of Divine Providence delineated in the Egg, whilst it is in the *Ovarium*, and before the Female is impregnated. Neither can it seem improbable, that so many parts should be described within the circumference of so small a Body, when we consider the minuteness of some Animalcula; and that notwithstanding they consist of Spirits, Humours, and a multiplicity of Organical parts. And if we suppose an analogy between these Eggs and the Seeds of Plants, which it is reasonable to do, the Observations which are to be made of the one, may direct us in our Hypothesis concerning the other; and favours our Notion, when we see the Rudiments, the Leaves, the Stem and Radicle of a Plant are to be found in the Seed, before it falls into the Womb of the Earth, and under the generating influences of the Heavens. It is

true, the parts of an Animal, whilst they lie within the compass of an Egg, are indistinguishable unto us; and must necessarily be so, until, and for some time after the Vivifick Spirit of the *Semen* has put the fluid and volatile Particles into motion; after the first and efficacious impressions of which, the affair of Generation seems to be carried on in this manner, *viz.* the Particles, which are the first Principles of the Humours, and all those which are disposed for an activity, being by this motion put into a Fermentation, are rarified and expanded; and thereupon, requiring a larger space than that which was capable of containing them, whilst they were more quiet, and by Nature disposed in such an order, as to lie within those bounds which the convenient magnitude of the Egg could not allow them to exceed before an Impregnation, they begin to dilate the Cavities and Vessels which contain them. Being put into motion, tho' at first it be languid, and proportionate to the tone of those parts which are afterwards solid, they naturally endeavour to persist in it. And although their first and natural tendency, after they are moved, cannot be thought to be the same in all the parts that are thus agitated, yet by the contraction and pulse of the Heart, it comes to be directed in all of them to the same general *terminus ad quem,*

quem, that is, the Veins. For whether this Fermentation be excited in all those Particles at the same time, which afterwards appear in the form of a Humour; or are exalted into Spirits; or be first begun in the *Punctum saliens*, or that which is afterwards the great Elevator of the Blood, the Heart, it will come to the same thing.

If the Fermentation be excited in all that matter contained in the Ventricles of the Heart, and all the Arterial Channels at the same time, though there follows a great variety in the tendency of the motion of these Particles, so that some fly one way, at least endeavour it, and others another; yet still the Heart has the ascendant over all of them, so that the pulse of this Machine, and the power and motion of those Particles, which are immediately propelled by it, direct the course, and order the tendency of all the rest; so that at last they come to be all moving towards the extremities of the Arteries, and to the Veins, which succeed to them.

If we suppose the Fermentation in the beginning to be partial, and excited only in that matter which lies within the Cavities of the Heart; as I am apt to think, that the Vessel which afterwards appears to be the Umbilical Vein, has its course always towards, and terminates in the Membrane of
the

the *Ovarium*, where there is a Pore, by which the spirituous Vapour, or fermentative Particles of the Seed entring the small duct, are conveyed to the Heart, and that to both Ventricles, in a manner, at the same time ; so that whilst one part of them actuates that matter which lay in the right Ventricle, the other, with their full vigour and vertue, communicate a motion to that which is contained in the left : and to this end nature seems to have formed the *Foramen Ovale* in a *Fætus*, by which there is a passage from the *Vena Cava* into the *Vena Pulminaris*, and so into the left Ventricle, without ever coming into the right, that some part of the Seminal Spirit may be immediately dispensed to the left Ventricle, and agitate the Particles contain'd in it, before it has spent or weakened its force by acting upon other matter. I say, if the Fermentation be thus partial, we may conceive how the Particles in both Ventricles, being rarified and expanded, dilate them, and oblige the Fibres of the Heart to a renitency and contraction, and so give them the occasion of beginning to make a Pulse, by which contraction, and the expulsion of some part of that matter which was lodged within the Cavities, they not only communicate a motion successively to those parts which are contained in the *Aorta*, and all the Vessels which

which are propagated from it, but direct and determine their motion towards the Veins : and thus the fluid parts begin their Circulation. And as by the motion and expansion of these Particles the Arteries are distended ; so partly by this expansion, partly by the more direct pressure of that matter which is in Circulation, the extremities of these Vessels, and the passages into the Veins, which begin where they terminate, will be opened, and so the circulatory course of the Blood will be continued into the venose Channels. And because the putting the Blood into a due and certain course of Circulation, is a business of great importance, absolutely necessary to the Life and regular encrease of the *Fætus*, as well as in the whole course of our lives after the Birth ; therefore there seems to be a particular contrivance for the more effectual accomplishing of this design in the *Canalis Arteriosus*, by which the Blood, that after the *Fætus* is excluded, is driven out of one Ventricle into the other through the Lungs, at this time passes directly out of the right into the *Aorta* ; and this Ventricle, which after the Birth neither adds to, nor determines the motion of the Blood in the great Artery, does evidently, whilst the *Fætus* is in the Womb, conspire with the left in the agitation of that matter which is in the *Aorta* and by the mediation

diation of the Particles which it immediately propels, makes a pressure upon it to drive it on in the Arterial Channels, as well as the left Ventricle does. The reason why the course of the Blood is diverted from the Lungs, I know, is commonly supposed to be, because the *Fætus* does not respire in the Womb. But this does not seem to me a sufficient reason ; for though it is not necessary that the Blood should circulate through the Lungs, upon the account of respiration, yet I do not see it would be either impossible or inconvenient for it, to have its course thro' them, before the *Fætus* is excluded, and comes to breath. There are the same passages or Pneumonick Vessels before as after the Birth. And what though the Lungs do always subside, do they not the same in expiration? Nay, does not the passage through these Vessels seem more free and easy, whilst the Lungs subside, than when they are inflated, and all the *Bronchia* and Vesicles distended, at which time the Blood-Vessels must necessarily be more compressed and streightned? But supposing the Blood could not have a free passage through the Lungs of a *Fætus*, and the defect of respiration forbid it ; yet this is no reason, why the right Ventricle should propel the matter it contains, into the *Aorta*, and not throw it into the left by some contrivance,

trivance, like the *Foramen Ovale*; so that we may reasonably think there was this design, to bring both Ventricles into a Conspiracy to determine the motion of the Particles, which are yet to be settled in a due course, to the Veins, and to drive them on through all the Stages of Circulation.

In the same manner, as the extremities of the Arteries are opened, that is, both by the expansion and direct pressure of the Particles which move in them, the Pores of the Glandules, whether seated in the sides, or at the extremities of the Arterial Channels, which before were closed, will be dilated, whereby they become fit for, and begin to perform secretions: then are the Spirits separated by the Brain; and when this habitation of the Soul is furnish'd, and as soon as a sufficient quantity of Spirits are supplied to irradiate the *Systema Nervosum*, then may probably be the time when the Soul of a humane *Fœtus* is infused, and takes possession. The Nutritious Glandules amongst others beginning to perform their Office, do give the Bones, and all the solid parts, a continual supply of such Particles as are of their own nature, and fit to be apposed to them; whereby they increase: and as the vigor and pressure of the Spirits grows stronger, and as it were, knocks these Particles nearer to one another, the
parts

parts begin to shew some solidity, to discover their nature, and become visibly distinct. And this Hypothesis, how strange soever it may seem to some, does give us a clearer and more intelligible Notion of the manner of Generation, and the effects of the *Semen* upon the Egg, than what has been said of that plastick power which has been supposed to be in the Seed of the Male, and to form the parts of an Animal from a rude and indigested *Chaos*. But I pass off from these conjectures to the consideration of that Subject I have proposed to treat of, which does in many things offer it self to our Senses, and encourages us with fairer promises of certainty and satisfaction ; and I begin with that part which first presents it self to our view and observation, the PERIOSTEUM.



Of the PERIOSTEUM.

THIS is a thin, transparent Membrane, made up of most minute and curious threads, endued with an acute sense, and expanded over the Bones. The Fibres, of which it consists, are not interwoven one within another, but disposed in several

veral Series one over the other. It is in some parts thicker than in others, and consequently less transparent. In some places it offers its superficies fairly to our view, that is, where no Muscles have their origination, nor are immediately inserted by their Tendons (tho' it is true, every where else there are some Filaments inserted into it from the Membrane of the Muscles); and where it may be observed, tho' it is not exactly smooth, it is more equal than on that side which lies next to the Bone; for on this part it has every where inequalities; some whereof are in the form of ridges, others are small Protuberances of divers other figures, some round like little Mole-hills, some Oval, &c. to speak briefly of which, they are correspondent to some superficial Cavities formed upon the Bones; which I shall afterwards have occasion to speak of. It has Blood-vessels, both Veins and Arteries, which are visible enough in the *Periosteum* of large Beasts, but they have nothing particular that is worthy of our remark.

About the Origin of this Membrane, I do not find that Anatomical Authors seem much to concern themselves, not so much as generally they do about that of the *Pleura* and *Peritonæum*. The account that may be gather'd from some few of them, is that the *Periosteum* of the Skull is from the *Dura Mater*, and that
of

of other Bones, from the Fibres of the Muscles. But since it is a Membrane common to the Bones, it does not seem so reasonable to suppose, that in one place it has an original so different from it self in another, especially considering that there are Muscles about the Head, as well as in other parts, from which it might be produced. And the best account of it that I could gather from a strict examination of this Membrane, is, that the Fibres which constitute it, are every where of two sorts; some of them are propagated from the *Dura Mater*; others from the Fibres of the Muscles. That the *Periosteum* of the Skull, which lies next to the *Cranium*, is derived from the Brain, appears not only from what has been commonly observ'd, that they are united, and the one continued from the other through the Sutures in a *Fœtus* and Infants newly born; but besides this, the *Dura Mater* passes out of the Skull at other places, as between the *Os Sphœnoidis* and the *Os Petrosum*; so between the *Os Petrosum* and the *Os Occipitis*; which is the reason why it adheres so firmly to that part of the *Cranium*. When it is got out beyond the Bones, between which it is double, it spreads it self both ways over the Bones, one part running one way, and the other another. And as the *Pericranium*, which I cannot conceive to be any other than the *Periosteum*

Periosteum of the Skull, owes the Original of one Series of its Fibres to the *Dura Mater*, so does the *Periosteum* in all other parts: therefore, in that part of this Membrane which lies next to the Bone, there are every where a Set of Fibres, whose tendency is direct from one end of the Bone towards the other, and without that Variety in their Position, which is often to be observ'd in those Threads which are deriv'd from the Muscles. This may seem improbable: for tho' we may easily conceive how those Filaments, which are propagated from the *Dura Mater*, may be continued from one Bone to another in the *Pericranium*, so far as the Bones are joined by Sutures, or Harmony; yet where the Bones are articulated and distinguish'd by visible Interstices, and when the Membrane which lies over those Interstices, is no part or continuation of the *Periosteum*, the course of those Fibres, which proceed from the outward Membrane of the Brain, must be interrupted, and after their termination, the *Periosteum* must necessarily be wholly deriv'd from something else. But this difficulty I soon got over, when I came strictly to examin the Ligaments of the Bones, where I observ'd a continuation of these Threads running upon those Ligaments, by which means they proceed from one articulated Bone to another.

Besides the Filaments, which arise from the *Dura Mater*, and make that part of the *Periosteum* which lies next to the Bone, there are another Set of Fibres, which are propagated from the Muscles and Tendons, which accede to it in every part as it proceeds: the Original of these, in some parts, especially upon the Bones of large Animals, is easy to be discover'd; for by taking one of the exterior Fibres of a Muscle, and separating of it gently, it not only leads us to the *Periosteum*, but I have trac'd some of them a good way upon this Membrane, where its superficies has been clear of the fleshy Fibres.

The order and course of the Fibres in this Membrane, is not the same in all of them: Those indeed, which are propagated from the *Dura Mater*, are every where parallel, and their Tendency, as I have already observ'd, is from one end of the Bone to the other; but for them, which are deriv'd from the muscular or tendinous Fibres, they are not constantly agreeable in their course and position; but as they differ sometimes from those which proceed from the *Dura Mater*, so those, which are propagated from one Muscle, have in some places a tendency different from them which are deriv'd from another; so that I have in the *Periosteum* of one of the Bones of the Leg observ'd three several series of Fibres lying
one

one over another ; the interior, or those next the Bone, were streight, the rest arising from two several Muscles, whose different situation gave their Fibres in their elongation a different tendency : those that were derived from one Muscle, proceeded obliquely one way, and they that were from the other, obliquely the other ; that they decussated one another in the same manner, as the Fibres of the obliquely descending and ascending Muscles of the *Abdomen* do. And according to the position of the muscular Fibres, with respect to those Threads of the *Periosteum*, which have their *Origin* from the *Dura Mater*, the Filaments which are derived from those Muscles, are sometimes parallel, in some places transverse or oblique to them which proceed from that Membrane of the Brain. Therefore I have in tearing of this Membrane of the Bones observ'd, that in some parts it has been more easily rent directly, that is, where the Filaments were all parallel, and observed the same tendency ; and in others, where some of them were oblique, or transverse, it was not so very difficult to pull it asunder that way.

However, the Tendons of many Muscles do propagate their Fibres to make some part of the *Periosteum* ; yet, I have observ'd that some of them, which have often a great stress or dependence upon them, when they act,

have not been so kind, but penetrated this Membrane, and were immediately inserted into the Bone; so that I could distinguish the *Periosteum*, which lay like a Circle round them: and this has given me an occasion to think, that all those Threads of the *Periosteum*, which are propagated from the muscular or tendinous Fibres, after they have run so far as to make up their part of this Membrane, are inserted into the Bone; and that they are particularly these, which, as I shall hereafter shew, penetrate into it.

From the account that I have given of the *Periosteum*, it may appear, how little reason we have to make the *Pericranium* a distinct Membrane from the *Periosteum* of the Skull: for altho' it be divided at the temporal Muscles, this is no more than what the several series of Fibres do make the *Periosteum* capable of in the Leg, or any other part; and I have upon the Shin-bone of an Ox divided it into four or five several Membranes, if I may so call them, when it has been dry'd.

The Adhesion of the *Periosteum* to the Bone is firm, and intimate, partly by contiguity, partly by continuity, or the insertion of some of the Filaments of the *Periosteum* into it; and by the Blood-Vessels which are propagated out of one, and ramified in the other, and like so many small Ligaments hold them together.

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By contiguous Adhesion I mean that union which arises from the immediate Coadjacence or Contact of two Bodies of a fixed Nature, where no matter either Volatile or Elastick intervenes, so as to concur with that force which endeavours to separate them; and is a manner of Conjunction, which some Experiments, that I need not here mention, do demonstrate to us. That part of the *Perio-steum*, which is thus united to the Bone, must be the Fibres, which are propagated from the *Dura Mater*, as being those which lie next to it. To add to the strength of this part of their Union, Nature has wisely contriv'd; for all Adhesion and Union of this kind being so much the more firm, as the Superficies is larger, in which the two Bodies, that are contiguous, do touch one another; the Surface both of the Bones, and their Membrane on that side, which is next to them, is so formed as to receive a considerable enlargement by incisions, and small superficial Cavities formed on the outside of the Bone; and by ridges, and other protuberances on that side of the *Perio-steum*, which is immediately applied to it. And I need not stand to shew how these inequalities enlarge their superficies beyond what it would be, if it were smooth and plain, since it is evident.

But to explain this Adhesion of the *Perio-*
steum by something that is more familiar,
and a Notion more intelligible, I conceive
that the Bones obtain very much the nature
of a Gluten. When their Generation has
proceeded so far that they have made some ad-
vancement towards their natural Temper,
they are like melted Glue; to which the *Pe-*
riosteum, being applied whilst they are soft
and viscous, does adhere, though not so firm-
ly at first; but as this Glue, I mean the
Bones, are indurated, and their parts more
fixt, the Union between them and their Mem-
brane is more and more confirmed, until at last
they are not easily separable. And as the *Pe-*
riosteum at first cleaves to the Bone whilst it
is soft, so afterwards in all the growth of it,
that matter which gives an increase to the
Bones, being, when it is first supplied and
apponed to them, viscous, like the substance
of a new formed Bone, is as apt to stick to
any addition made to the *Perio-steum* in its
growth, as the Bone it self was to cleave to
its Membrane at its first Formation. Neither
is this Notion of the Adhesion of the *Perio-*
steum to the Bone in such a manner, as if they
were joined by Glue, merely conjectural, but
grounded upon a small Experiment I made.
I took a piece of a fresh Bone, and dissolv'd
it in *Aqua Fortis*; then I set it over the Fire
in

in a glazed Vessel, and evaporated so much of the liquid part, that I reduc'd the Solution near to the consistence of a Jelly; then I set it to cool: after it was cold, it not only resumed its hardness (though it was more brittle) but adhered to the Vessel as intimately and firmly as ever I have observ'd Glue it self to do to a Vessel of the same kind. Besides, the Bones in a *Fætus* are plainly gelatinous and viscous at one time; and in a Calf, which I had taken out of a Cow sometime before it was to be excluded, where the greatest part of the Bone was in some measure indurated, I observed such a gelatinous matter between that part, which was more solid, and the *Periosteum*.

Besides this manner of Adhesion, the *Periosteum* is united to the Bone by little *Fibrillæ* or Threads continued from the one, and penetrating into the substance of the other, which may be observed in a perfect Bone, especially in some places. But I discover'd it more plainly in the Bones of a Calf, which were tender and imperfect; where I found the Threads penetrating that gelatinous Matter which lay under the *Periosteum*, and beyond it were inserted into that part, which was indurated, out of which I could draw some of them.

By these Fibres, and the mediation of the *Periosteum*, it is probable that the Bones have some internal sense; so that they may be said to be sensible, not only in their Membrane, but even in their substance. When we consider how the Teeth, which are at least in the stony Cortex of that part which stands out of the Gums, more solid than any other Bones, will be affected by injuries, which make no immediate impression upon the Nerve, which lies in their Cavities; as to instance only in that particular sort of sense they have upon the application of Acids, when their *Mucus* is scoured off, which we term setting them on edge; what is this but a sensibility of Bones? considering that this sense must be by the *Fibrillæ* of the Nerve inserted into them, that these Nerves answer for the defect of the *Periosteum* in that part of every Tooth which stands out of the Gums, and that this sensible Membrane does propagate Threads into all the Bones; how can we think but that any irregular and tumultuous motion in the Spirits of these solid parts is communicable to the Brain by the mediation of those Fibres which are derived from the *Periosteum* into any Bone, as well as by the Nervous Fibres which are dispers'd in the substance of the Teeth. And to confirm what I now say, there is an observation

servation of *Nicolaus Massa*, which *Diemerbroek* mentions, of a Man that had an ulcerated Leg, where the Bone, which was deprived of its Membrane, was so sensible, that it could not be touch'd without pain; nay, the Bone was Perforated, and he found it had a sense in the internal part, which gave him the suspicion of Nerves; but he has left it to others to find them: and as I could never with the strictest enquiry observe any such thing, so I have shewn how the want of Nerves is supplied; and we may be able to account for the sensibility of the Bones without their proper Nerves.

I come now to consider the Design and Use of the *Periosteum*. And first, it is to be a Tegument to the Bones: for Nature, in the Formation of all the parts, is found to be Elegant, as well as Provident: and tho' it could be granted that this Membrane serves to no necessary use, yet it is for decency.

Secondly, It conveys Spirits into the substance of the Bones for maintaining their Heat, for preserving their Sensibility, and to assist in the Work of their Accretion and Nutrition. How this Membrane immits minute Fibres into the Bones, I have already observed; and I do suppose they are continued so far as to be *Infundibula*, and disembogue themselves
into

into the Interstices of the bony Strings, in which the Spirits afterwards move as their Channels; and therefore some of these Fibres insinuate themselves farther into the Bone than others, as the Interstices which they serve to, are more remote from, or nearer to the Superficies.

Thirdly, It seems to be one thing, which checks and helps to set limits to the growth and extension of the Bones. Whilst this Membrane is growing, and capable of being farther expanded, so long it allows the Bones the liberty of enlarging their dimensions; but when it ceases to be extended, and cannot admit of their increase without a rupture, then there is some stop put to their growth. Therefore we shall find, that the *Periosteum* is stretch'd upon the Bone to its utmost extent; so that when it is divided in any part, either directly or transversely, and raised from the Bone, it is so streight and correspondent to that part which it was applied to, that the *Libia*, where it is divided, cannot fairly, and without tearing of it, be extended, so as to be brought to lie one over the other. Neither will it seem improbable that so thin a Membrane should hinder the increase of the Bones, if we consider the strength of it, and how we have instances that seem very like it in Trees, where the Bark is often observ'd

serv'd to bind them when they are young; so that it is necessary to open it before they can have the liberty of thriving. And even amongst Animals, it is not unknown how the Skin of a Horse, which is naturally more Tenfile when he is Hide-bound, as they term it, checks and hinders his growing. Not that I think this is the only or principal thing that determines the measure of the Bones Accretion; I only suppose it conspires with another Cause, which I shall explain when I come to speak of Accretion; and to shew the reason why it ceases in full-grown Animals.

Fourthly, The *Periosteum* is serviceable in the Conjunction of the Bones and their Epiphyses, whilst the substance of the Epiphyses is cartilaginous; of those Bones, which are joined by Sutures of Harmony, and in the connexion of the Bones and their Cartilages: for being a strong Membrane, and firmly adhering to any of these parts which are to be united, and not being Tenfile like some other Membranes, it does not suffer them easily to recede from each other, or to be displaced; which cannot be without a disruption, or a disengagement from one of those two parts which it holds together. This, tho' it be not the same thing as the continuation of the same Body; yet it does
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in a great measure answer to it, and is a manner of Conjunction, which Art does often imitate. And I not only suppose this to be one Use of the *Periosteum*, but it is very evident where the Cartilages are joined to any Bones: for if we take the *Scapula*, or any of the Ribs, and divide this Membrane round that part where their Cartilage is united to them, though there is another contrivance for their Conjunction, yet they will be easily separated.

Fifthly, It serves for another considerable design, and that is, to join the Heads and Tendons of the Muscles fast to the Bones: for altho', as I have already observ'd, the Tendons of some Muscles do penetrate this Membrane directly, and are immediately inserted into the Bone; yet the Origination and Tendons of a great many Muscles have their immediate dependence upon the *Periosteum*, by whose mediation they are fastned to the Bone. And for this Reason it seems to be, that Nature has made the Adhesion of this Membrane to the Bone so firm by that contrivance which I have taken notice of.

Sixthly, and lastly, If the sense that this Membrane is indued with, was intended with a particular respect to the Bones themselves, as it seems to be, and not merely a Consequence, as the *Periosteum* is propagated
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from such parts as are acutely sensible, it was design'd for the safety and security of the Bones from external injuries ; for the discovering to us the part affected, when they are distemper'd, and directing us in the application of external Remedies. As for other inconveniencies and injuries which follow upon any external violence, excepting the pain which they threaten, they are not so suddenly thought of ; but this evil of pain we have a natural and an immediate abhorrence of, without any deliberate thought or consideration : and as the apprehensions of it, so our endeavours to prevent it, are quick ; and as this obliges us to watch over them, so it makes us withdraw them hastily from any sudden dangers or appearance of Mischief. Thus for the security of the Eye, which in the *Tunica Cornea* has no sense, Nature has given it one, which is acutely sensible ; and the design certainly is, that the pain, which the *Tunica adnata* is obnoxious to, should give us the occasion of shutting our Eyes against any thing that may excite it ; and consequently serve for the security of the whole Eye. And thus much of the PERIOSTEUM.



Of the Nature and Constituent Parts of the BONES.

NOW I have laid aside the *Perio-*
steum, the next thing which comes
in view and under our examina-
tion, is the BONE it self; and I
shall enquire,

First, Into the Nature of the Bones, which, like other products of Nature, have their infancy, or first beginning, their improvement and tendency to maturity, and their perfection. At their first beginning they are soft and gelatinous, that is, whilst their proper parts not only are disunited, but have a mixture of such moist and loose Particles which intervene, as are neither apt themselves to be fixt, nor will suffer those which are fit to make a Bone, to unite; as we see water insinuating it self between the Particles of *Gum Arabick*, or any Body of that Nature, destroys its hardness and rigidity, and renders it soft and gelatinous. When they advance near the temper of a Bone, they are cartilaginous; as those Particles, which are fit to make a Bone, are driven

driven nearer to one another by the power of the Spirits, and the pressure of that Nutritious Juice which they drive to, and crowd against them, they express and begin to free themselves from those parts which lay between them, and hindered their mutual access, and that union which was requisite to make a solid Body of them: but still these Particles are not united at their extremities, which makes the parts, which they constitute, remain as yet less solid, and more flexible than a perfect Bone. But when the Bones are grown to that perfection to obtain their proper Nature, they are solid, and consist wholly of Parts, which are naturally fixed, and void of motion; which being united, do all Conspire to resist a Pressure, and any endeavours to disturb and disunite them; so that they can neither be agitated by Subtle and Volatile Particles within; nor be moved and disordered but by some great and extraordinary violence from without. These parts are of two sorts; to wit, Terrestrial, and Saline. It is true, if we come to torture a Bone with the Fire, it seems to confess that it consists of all the five Chymical Principles: it affords us a Spirit, and Phlegm, a Volatile Salt, and an Oily or Sulphureous Substance, in which there is the same difference to be observed as in the *Medulla*; one part is soft and liquid, the other is

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is more indurated like a *Sebum*, and the hard part of the Marrow: after these parts are abstracted, we have the Earthly, and some fixt Saline parts remaining behind. But these several parts are found in a great disproportion; the Terrestrial only are, after a thorough and perfect Distillation, above two parts of three, which I take to be the truest account of their quantity. I have after a long Calcination of Human Bones, found them to be five parts of nine; but by the continuation of the Fire, they still loose of their weight, so that I could not here tell where to fix the quantity of them. The fixt Salt is very little, and indeed but just so much, as that we may say, they have some. The Volatile Salt was about a thirtieth part: the Spirit, and Phlegm, are not so plentiful as in Harts-Horn, being about an eighth, whereas in Harts-Horn they are above a fourth part: the fluid Oil a twenty fourth, besides a good quantity of that oily Matter which was indurated, and stuck to the upper part and sides of the Retort. But to speak truly, these cannot all be properly said to be the parts of a Bone: the Spirits and Phlegm are drawn from the Blood-Vessels, and the Interstices of the bony Strings, in which the Spirits flow whilst the Man is alive, and the Oil is plainly what had been supplied from the *Medulla*, and insinuated
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into the substance of the Bone by Pores, which I shall hereafter describe; so that none of all these can be said to be the parts of a Bone any more, than the blood may be said to be the part of a Vein, or an Artery. That which we call the Volatile Salt, at least the greatest part of it, I take to be a Constituent part of a Bone; and however it is raised and brought over by the Fire; yet the Particles of it are solid, and fit to be one ingredient in these hard and rigid parts, in which, whilst they are lodged, they are fixt; as we find after Distillation they will be Chrystallized, and resume a solidity: besides, this Salt does shew much of a fixed Nature upon the Tongue, when it is tasted, having such a kind of sensible coldness as *Sal Prunellæ* has.

The Particles of which the Bones consist, when we consider how they form Strings, seem to be of a long Figure, and their position streight, so that one end lies towards one, and the other towards the other extremity of a Bone in the sides of it. I say, in the sides, because where the Strings alter their course, and run Obliquely or Transversely, as in the *Cancelli* and small Caverns of the Bones, and at the extremities where they lie over, and shut up the Cavities, the position of these Particles must be different. Perhaps I may seem to contradict my self, when I say, the bony

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Particles are of a long Figure, and yet make the Bones to consist of two different Principles, which may be thought to be en implicite Affertion that their Particles are diversly figurated. But it is very consistent with the Notion I have of the Particles of all, at least solid Bodies; which is, that none of them have the true and distinct Nature of any one pure Principle, but are a composition of two, or more; and from the proportion of the Principles, and the manner of their mixture or union, arise the Figure and Nature of the Particles which they produce: so that, though there is certainly a difference in the Figure of the Particles of every Principle; yet those which are formed from the Union of two, or more of them, may all be alike figurated in a Body which contains several Principles.

The bony Particles are in every Series united at their extremities, and by this Union they form continued Threads or Strings; which continuity gives the Bones a rigidity. The course or tendency of all these Strings in the sides of a Bone, is as the position of the Particles, from one end towards the other; and wherever the *Laminæ*, which they make, are contiguous, they are Parallel, and so far streight as the Figure of the Bone will admit. Their course is no where more easily to be discover'd in the Bones either of Men or Brutes

Brutes, than in the Ribs, where some of them may be separated, and run in the form of a String sometimes for some way together. And if we suppose, as we must do, the Horns of Beasts to be of the Nature of Bones, there are some of them which plainly discover thus much to us, that the Bones consist of several small Strings; as particularly in the *Rhinoceros* Horns in the Repository their Strings are actually divided, and their course visible at their Basis. Or if we may make a judgment of our own Bones, and those of Birds and Beasts, by Animals of another Element, the Whale-bone does sufficiently demonstrate, both that they consist of such Strings, and that the course of them is from one end towards the other. In short, in all the Bones, even those which are not to us divisible into stringy parts, their tendency does evidently appear in the Fissures, which are many times to be observ'd in them when they have lain in the Sun, or are any ways dried so as to crack.

These Strings, tho' some of them run to the very extremities of the Bones, and others approach near to them, do not terminate there, so as to have distinct ends, but they are, where they may be thought to terminate, still continued, and run transversely, and as it were, Arched, that the Strings of one side of the

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Bone proceed so as to meet and be united to those which are propagated from the opposite, and this at both extremities ; that they are a continuation, though not of the Figure, yet in the manner of a Ring: therefore they are not all of a length, but in every Plate they fall one shorter than another. Those which make the external Plate, run from one end quite up to the other, and are the full length of the Bone, and in some few other *Laminæ*, which lie nearest to this, they want no more than the thickness of what is above them, and do every where, as well where they proceed transversely, as where they are streight, keep a sociable course ; but in all the other Plates they come more short of the length of the Bone, and run off from them which close up or make the extremity of it, only by some Corrugations and Apophyses, which form the small Cavities they come to meet, and to be united in some certain places. The Strings of the first internal Plate of those Bones which have a large Cavity, do plainly first divert from the side, or rest of the Plates into the interstice ; after these the Strings of the next *Lamina* : and thus they run off one after another, till we come to the extremity, where those of some few of the external Plates, which remain running transversely without any irregularities or *Plicæ*, and being

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contiguous, as on the sides, make a thinner, but compact part, which covers and shuts up the ends of the Bones. And as the bony substance of which the *Cancelli* and the small Cavities are formed, is a continuation of the Strings from all sides of the Bones, in those which have the large Cavities; so from the first appearance of these *Cancelli*, or the first formation of the small Caverns, where there is nothing of that reticular texture, as the Strings of every *Lamina* strike off to make them, the side or Wall of the Bone grows gradually thinner towards the extremity, so that by that time we come to the end of it, we have not above a fifth, or sixth part, and it may be less, remaining to make the thickness of that part. Thus in the *Os femoris* of a Human Skeleton I have observed the thickness of the side before any of the Strings ran off from it to be five times more, than that of the Head: so that if we suppose the side to consist of five and thirty Plates, then has the Head but seven, which lie contiguous to one another, and inclose the Cavity.

Perhaps it may not be so easily understood how the Strings of the exterior Plates are continued at the ends of the articulated Bones, which are covered with a cartilaginous substance, supposed to be distinct from the Bone: but the parts of which these Cartilages con-

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sist, are the same as those which make the Strings in the more solid part disposed in the same order; so that the Series of the Particles of so many Strings, as answer to the thickness of the Cartilage, run through it, and would be continued in the Nature of a solid bony String, but that the liquor which is continually supplied to the Joynts, will not suffer the Particles to be so intimately united, as to render that substance of that part equally hard.

The Bones, in their firm and solid part, and where the small Cavities are distinct, consist of several *Laminæ*, or thin Plates, lying one within, or under another; so that there is this subordination in the Constituent parts of a Bone: A proportionate quantity of Earth and Salt duly mixt, produce the Particles; the Particles regularly disposed and united at their extremities in every Series, form the Strings; the Strings laid in a convenient Order and Number, and so united, form the Plates; and these Plates make up the Bone. I say, the Bones in their solid part, and where the small Cavities are distinct, are formed thus of Plates; because where any part of their Structure is like Network, or *Cancelli*, which are to be found in many of the Bones of a Human Skeleton, and more than in other Animals, the Strings are not so order'd and united as to make any Plates, but run into several *Fasciculi*

ciculi of those smaller Strings. Now since the Strings, of which these *Laminæ* consist, are, as I have already shewn, after the perfection of the Bone, so continued from one side to the other as to have no distinct extremities, every one of these Plates, excepting those which have their Strings at any end running into *Fasciculi*, could they be divided entire, would be like a Tube imperforated at both ends. Yet I did in two Oxes Bones, which were fresh, meet with a small *Lamell*, which lay next to the *Periosteum*, that fell much short of the length of the Bone, and did not lie round the Cavity, so as to be Tubular, but I look'd upon it to be extraordinary, and not agreeable to the common method of nature.

There is some difference in the manner wherein the *Lamells* in several Bones are disposed: where there is a large Cavity, they are on every side contiguous, and closely united; and the small Caverns and *Cancelli* which are at the extremities, are produced from Plates and Strings propagated from the sides: but in the Bones which have not any great Cavity, but are altogether spongy within, many of the internal *Laminæ* are plac'd at some distance from one another in all their length, excepting in those several places where the flexure of their Strings this way, or that, and their Apophyses bring them to meet; and be-

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ing thus modified all along, just as they are at the extremities only of the Bones, which have a large Cavity, they produce in the whole internal part the same sort of small bony Cells. And because many of the Plates within stand thus distant from one another, they fill up the whole space within the Wall or solid part with such a cavernous substance; and therefore the sides in these Bones are thinner, and the Plates which are contiguous and are their solid part, are fewer than in those which obtain a large Cavity.

On the inside of the *Os Humeri* of a Human Skeleton, I have sometime found the first Plate, from one end of the Cavity to the other, putt up in several places, so as to form conspicuous Cavities under it; but round every one of those Cavities it was deprest, and remained united to the next *Lamina*; and where it was thus elevated, I took notice of a great many Pores, by which I do suppose the Medullary Oil did pass out of the large Cavity into those which were under this Plate, and were some of those transverse Pores, by which the Marrow is conveyed in order to diffuse it self between the *Laminae*, and which I shall presently give an account of.

Of these Plates I have in one Bone with a Microscope numbered sixteen together, and by computing the number of those which I
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could not so well distinguish by the thickness of them, which were discernible, I reckon'd them all to be three or four and thirty. In another Oxe's Bone I counted one and forty together, which I could plainly discover; the rest I could not so well, because they did not lie so streight and regular on that side next the Cavity as that I could be certain as to their number, but yet I discerned they were distinct Plates, and I numbred them so well as I could, which were by that account fourteen, so that they were in all five and fifty.

That the Bones do thus consist of several thin Plates lying one over another, we have presumptive evidence from their exfoliation; and considering how much the Horns of Beasts participate of the Nature of Bones, and how many of them may be actually divided into several thinner *Lamells*, this may induce us to think that the Bones are in the same manner made up of *Laminæ*. But we have further evidence of it, as they may be distinguish'd with a Microscope; and not only so, but I have actually separated them in several Bones, particularly I have taken some of the thin and fine *Laminæ* off from a piece of a human Skull; and in one Bone I had, I could divide the whole Wall from the Cavity to the external superficies into Plates, tho' some of them, I must confess, were thicker than others:

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thers: but when I viewed any of the Plates with a Glass, and number'd sixteen or more together whilst they were yet united, I could not discern any such difference in their crassitude; so that I am confident, that those which I found, upon separating of them, to be thicker than others; and which I could not divide into such thin and curious Plates, as I did some, did consist of thinner and finer *Laminæ*.

The manner how the Bones consist of several Plates, included one within the other, and how the small Caverns and Lattice-Work are produced, I have endeavour'd to express in the first Figure, Tab. I. where *a, a, a,* are the Plates in the sides of a Bone, which must be supposed to be contiguous, although I have made them distant, to represent them distinct: the three exterior of which are parallel and contiguous at the extremities *b, b,* as well as in the sides *a, a, a.* *c, c,* is the Lattice-Work produced from the Strings, propagated from the Plates *d, d, d, d.* *e, e,* are the Caverns formed of the Plates *f, f, f, f, f, f,* which run off from the side successively where the crassitude of the solid part appears gradually diminish'd. *G* is the large Cavity, and *h, h,* the passage of the Medullary Vein and Artery.

In the Bones, thro' and between the Plates, are formed Pores, besides those which are made for the Passage of the Blood-Vessels, which are of two sorts; some penetrate the *Laminae*, and are transverse, looking from the Cavity to the external superficies of the Bone; the second sort are form'd between the Plates, which are longitudinal and streight, tending from one end of the Bone towards the other, and observing the course of the bony Strings. And that I may not be thought to pretend to the discovery of what no other mens Eyes can discern, because they are generally very difficult to be observ'd, unless it be the transverse Pores in the internal *Lamell*, I have the pieces of two Bones, which I have brought along with me; in one of which the transverse, in the other the longitudinal Pores are very visible with the help of an ordinary magnifying Glass.

The first kind of passages are formed not only in the first internal *Lamina*, but in every one, even to that which includes all the rest; and I have not only seen them sometimes in those parts of a Plate which in the Cavity have been naturally puffed up, and raised from the side of the Bone, and in the next *Lamell* to that, but I had the satisfaction in that Bone which I resolv'd into Plates, to observe some of them in all the Plates. Tho' so far as I have

44 *Of Transverse Pores in the BONES.*

have observ'd, the nearer they are to the Cavity, the greater is the number of these Pores, which in the first internal Plate are very numerous. Now this difference in the number of the transverse Pores, besides what I gather from what I have observ'd, we may suppose for these two Reasons; first, because the quantity of Marrow, which is to pass thro' them, is less, and less as it approaches nearer to the outside of the Bone; for the Marrow being supplied from the Cavity, every Plate transmits so much as is necessary for its own use, and all the Plates that lie above it; so that every one, as it approaches nearer to the superficies, having a Plate less than another to transmit the Medullary Oil to, there is occasion for a smaller number of these Pores in one than in another. Secondly, because it was necessary the Bone should be very solid towards the superficies where it is exposed to external injuries. About these passages I was particularly strict in my enquiry, whether they were not formed for Blood-Vessels, tending either to or from the Marrow: and although some of the Medullary Veins have Pores, by which they penetrate into the substance of the Bone, yet I made my self certain, that these Pores, for the generality of them which I examined, had no Vessels which passed into them. These transverse Pores do not ob-
serve

Of Transverse Pores in the BONES. 45

serve any such order as to lie directly one under another, to form one continued passage from the Cavity to the external Plate. This could not be, but Nature must either have been frustrated of her end in making them, or injurious to the solidity of the part. If they had been continued thro' the whole thickness of a Bone, and limited to their present number, without the other Pores which are formed between the Plates, it had been but a small part of the substance of a Bone that could ever have been touched, and had the benefit of that oily matter which they serve for the dispensation of. If they had been so thick and numerous, as that all the substance of a Bone could have been oiled by the insinuating Marrow, without the longitudinal Pores, this had been as injurious another way, and such a porosity would have destroyed that solidity and firmitude that were necessary in these parts which are the Timber-Work and Supporters of all the rest; for the transverse Pores, which interrupt the continuity of the Strings that constitute the Plates, would have detracted much more from the strength and rigidity of the Bones, than those which are formed in the length of the Strings, and between the *Laminæ*; which is easily demonstrable. But by the contrivance which appears, Nature attains one end in such a method

46 *The Transverse Pores in the BONES.*

thod as does not disappoint her of another ; but both makes her Bone firm, and in the dispensation of the Marrow is just and kind to the whole substance of it.

As the transverse Pores are differently plac'd in the several Plates, so as not to receive the Medullary Oil immediately one from another, so those in the same *Lamell* are disposed with a seeming irregularity, and scatter'd, not being digested into such an order as to form Circles, or exact series of Pores round it; which thing is yet regular and reasonable, and without doubt is done *ex proposito*, that the Plates might not be weaker, and more apt to be broken in one place than in another: for altho' they had not exceeded their present number, yet supposing they had been set in several series round a Plate, so as to delineate Circles about it, this would have made it more infirm and apt to be broken in those than in other places, or than now it is in any part.

Besides these, there are longitudinal Pores formed between the Plates, which in the sides of the Bone have a tendency from one end towards the other, and where the Strings alter their course, and are transverse to the Cavity that is at the extremities ; they still run along between the Plates, and change their Position as the Strings do. These are not
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very commonly to be observ'd, nor without a strict inquiry and good Glasses, unless it be now and then in some particular Bones. There are none in which they are oftner capable of being observ'd than in the Ribs; tho' I have in the firmest part of a *Scapula*, where the Plates were immediately united, plainly discerned them, and even seen the Marrow which had insinuated itself into them, sticking to their sides in the shape of an Oil. I have likewise had the satisfaction to observe them in a human Bone, and that between eleven or twelve several Plates. By these it is that the Medullary Oil diffuses it self, and is immediately beneficial to the Plates: the transverse Pores are subordinate to these, and rather designed for the passage of the Marrow into them, than for the immediate communication of it to the substance of the Bone. The manner therefore, in which the Medullary Oil insinuates it self thro' a Bone, and is dispensed to all the parts of it, is this: it first passes, being liquid, as it all is whilst the Animal is alive, out of the Cavity thro' the transverse Pores of the first internal *Lamina*, and not having Pores of the same kind directly subjacent in the next Plate to transmit it towards the outside of the Bone, it flows into the longitudinal Pores formed between these two, the first and second Plates, and
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48 *Of Longitudinal Pores in the BONES.*

being carried along in them till it finds some transverse Pores in the second Plate, it passes thro' these; which when it has done, it is again obliged to alter its course, to run into, and flow along in the streight Pores between the second and third *Laminae*: thus it passes through and between the Plates successively, till it has made its way thro' the solid part to the external Plate. Thus the Medullary Oil is dispensed in all the Bones to those Plates which are contiguous, and have no intermediate Cavities to entertain any Medullary Glands of their own; but where any part of the Plates stand at some distance, being only united by intervals, as their Corrugations bring them to meet in some certain places, there we have the small Caverns, which are capable of containing some Medullary Glands; so that here the Plates have more immediately, and without the former method of conveyance, the benefit of the Marrow.





*Of the Superficies of the Bones,
their Passages formed for the Medullary
Vessels, and their Cavities.*

NOW I have consider'd the Constituent parts of a Bone, I proceed to examin it entire, and to take notice of the structure which arises from the composition of its parts, and the order in which Nature has disposed the Plates: and the first thing which falls under our observation, is the Superficies, which in all the bones, excepting only at the ends of those which are articulated, where it was necessary that they should be smoother, to make them more fit to be moved and managed by the Muscles, is remarkably unequal (tho' more in some than in others) from Cavities, whereof some are superficial, others are passages which penetrate farther into their substance; the most conspicuous of which are those through which the Blood-Vessels of the Marrow and the Arteries, which are designed for the nourishment of the Bones, do enter.

The superficial Cavities, which some may think to be accidental, are not the careless strokes, but the design of Nature, and are those inequalities which I have already in speaking of the *Periosteum* observ'd to be a contrivance to enlarge the superficies of the Bones, and to strengthen the adhesion of that Membrane to them. They are of two sorts, some are long, and these we may call *Sulci*, or Furrows; others are more contracted in their length, and of a different Figure, which may be distinguish'd from the former by the name of superficial Pits or depressions.

Of the *Sulci*, some are larger and broader, some longer, and some more superficial than others. But they all generally agree is this, that they observe the position of the Particles, and the course of the Strings in the Plate in which they are formed, so as to run directly the same way as they lie, though in the *Os Hyoides* I observed some few of them to be different; some were of the figure of an S, and others were plainly Oblique to the course of the Strings.

Of the superficial Pits, some are broader and larger; others, and much the greatest number of them, are smaller. Many of these last are round; those which are larger, are irregular in their Figure, and seem to be a sort of *confluentes*, or several of the little Pits run one in-

to another. I have in some of these larger depressions observ'd others that were small; that there were Pits within a Pit. I have, though rarely, seen of these superficial Cavities running a little way under the Plate in which they were formed, into which the *Periosteum*, by a Protuberance answering to it, did insinuate it self.

These inequalities of the *Sulci* and superficial depressions do not observe the same proportion in their number in all the Bones; some have more Furrows, some more Pits than others. The *Os Humeri*, and the *Tibiæ*, and especially the Thigh-Bone have a great number of the Furrows, some of which are deep and considerably long, three inches and more. Besides these they have the superficial depressions, and that some of them in the very Furrows themselves, which are large. The *Ulna* and *Radius* have Furrows too as well as Pits, tho' the first has the greatest number of them. The *Fibula* has considerable Furrows in some places, though it has not so many to shew us, but abounds chiefly with the other superficial Cavities. Some of them are likewise to be observed in the Bones of the *Metacarpus* and *Metatarsus*. Thus they have appeared in those Bones, where I did industriously observe them: but I see little reason why they should be constantly alike in all Skeletons,

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52 *Of the SUPERFICIES of a BONE.*

letons; so that it is probable, Nature does here change her hand in some Subjects, and form more superficial depressions, or more Furrows in the same Bones of several individuals. In short, many of the Bones have some of both sorts, and all have the superficial depressions. But in the upper part of the *Os Frontis*, and in the Bones of the *Sinciput*, at those Angles which meet in the Coronal Suture, and all along on both sides the *Sutura Sagittalis*, I have observed in several human Skulls, not so much this contrivance of superficial Cavities for enlarging their superficies, and strengthening the adhesion of the *Periosteum*, as numerous Pores, penetrating into the substance of those Bones; particularly in one of the Skeletons in the Repository they are very numerous, exactly representing the transverse Pores of the internal *Lamina* in the large Cavities of the great Bones of the joints; and in one Skull I found many of them planted more backward down the middle of the *Os Occipitis*. The same I have met withal in the *Os Frontis* of an Ape: and in a Tyger, where I suppose the Tendons of the Temporal Muscles reached to the Sagittal Suture, I found them only in the Bone of the Forehead; and I observ'd the like in the *Ossa Sincipitis* of one Rhinoceros, on both sides of the Sagittal Suture. The reason of which difference to
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me seems to be this; because where these Pores are to be observed in the Bones of the *Sinciput*, there are the Tendons of no Muscles inserted; so that there was no reason to contrive for so firm an adhesion of the *Pericranium* to these parts; and indeed not much more in the *Os Frontis*: for tho' there are Muscles which have their Origination from it, yet they are no more than the *Musculi Frontales*, which only Corrugate the Fore-head, and help to raise the upper Eye-lids when we would open them very wide, and so have no great stress or weight depending upon them when they act. Since therefore there was no great occasion for the superficial Cavities, Nature in those Parts of the Bones I now mention'd, has form'd Pores to another end, and may here be thought to be upon a design for the preservation of our Health, and the greater security of our Lives. As it was requisite that the upper Region of our Bodies, where the Soul, that actuates, the Sun, that irradiates the lesser World, is seated, should be clear, free from Clouds and Vapours, so these Pores seem to be formed as one way, to expel and scatter those moist and misty Particles which may be apt to eclipse or weaken the influences of that Principle which animates us. I do therefore conceive that they are *Perspiracula*, by which the offensive

Vapours, which arise and gather within the *Cranium*, do perspire. And it may seem more probable, if we consider how Sweats do easily and frequently arise in the Forehead, even when they are not discernible in other parts: to account for which we may reasonably suppose that there is some other way of evacuation, besides what is made from the Mass of Blood by the Cutaneous Glands, which are to be found in any part of the Skin as well as there. I know, the practice both of antient and modern Physicians have in taking off the Hair, and the application of Plaisters, as well for clearing as strengthening of the Brain, directed to have them done upon the crown of the Head: not that they did, as I can find, ever take notice of these Pores, tho' Anatomists do suggest that the substance of the Bones of the *Sinciput* are therefore thinner and more rare than that of the other Bones, that there may be a more free and easy exhalation of Vapours; which implies a supposition that there are such Pores. I must confess I have not met with them in all the Skulls that I have examined; and perhaps the difference may make some variation in the state of the Brain: the want of them may be the occasion of a natural dulness and cloudiness; it may render us obnoxious to a frequent Head-ach, not only upon the accident of a Cold, or any other

other evident occasion, but even where the Crasis of the Blood is good, and no accountable cause has fallen under our Observation.

Whilst I suppose some of the serous Particles, which are evaporated in these parts, to come from the Brain immediately, or without the mediation of the Blood-Vessels conveying them to the Cutaneous Glands, some will be apt to think I speak as if I had never heard of those Glands, and did not understand the manner in which the *Serum* is commonly excerned when we Sweat. But that there are subtile Vapours continually arising within the *Cranium*, I think cannot be denied; and that they are successively excluded as they arise, is as certain. Whether they pass through the Skin by the Cutaneous Glands, or some distinct Pores, is not material; but the question is, whether the Cavity of the *Cranium* be freed from them *mediante sanguine*, as they are reformed by the Blood-Vessels, and carried in the Mass of Blood to the Cutaneous Glands; or whether there be not a more immediate way by Pores and Interstices in the parts guiding and carrying them, tho' perhaps meandrically, to the external part of the Head. This I am sure we all seem to grant, that there are such immediate passages, by which not only the tenuious Vapours, but more gross and morbifick Particles may be evacuated out

of the Cavity of the Skull, when we prescribe Issues in the Neck and upon the crown of the Head in any Cephalick Distempers: for if they were not conveyed some other way than by their return into the Mass of Blood, and their Circulation thro' the *Sanguiferous* Vessels to these artificial *Emunctories*, I do not apprehend why an Issue in the Heel, or any other part should not be as proper and beneficial in those cases, as in that part where we so precisely order them. Some that perhaps would allow such a Perspiration as I speak of, if the including parts were membranous, will object the thickness and solidity of the Bones thro' which these Vapours must pass; but if they do consider those two sorts of Pores, formed in the most solid part of a Bone, which I have before given an account of, they may be satisfied that even these solid parts are permeable to a thin and tenuious matter.

Besides their superficial Cavities, the Bones have all of them deeper impressions, *Foramina*, which not only render their superficies unequal, but penetrate far into their substance; where the most remarkable, and they that deserve or admit of our particular notice, are those by which the Blood-Vessels pass through the side of the Bone to the Medulla. The *Foramina*, by which the nutritious Arteries enter the substance of the Bones, are

are in some places very visible, but not so conspicuous as the other, nor so constantly agreeable in all things that they can well be particularly described: in general, many of them are at one end of the Bone, and the contrary to that where the Veins pass out; and there are some planted in the intermediate parts between the two extremities, which are but small. The passages of the Veins, excepting them which accompany the Medullary Arteries, are very numerous and minute, but there is nothing particular in them to be observ'd excepting their number.

As for the passages of the Medullary Arteries, and the Veins which accompany them, as they are but few, so they are considerable. This is to be remarked, that they do not penetrate the side of the Bones, especially those which are articulated directly into their Cavities, but with an obliquity, like the passage out of the Ureters, running for some way between the Coats of the Bladder, before it opens into the Cavity; so that I have found this passage sometime to be an Inch and half, when the thickness of the Bone was little more than the eighth part of an Inch. In this manner they are generally formed in Beasts and Fowls, as well as Men; but more obliquely in Men, and some sort of Beasts, than in others. In two Rhinoceroses some
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58 *Of the passages of the Medullary Vessels.*

pass almost directly through, and none of them so obliquely as in Men and some other Creatures: the reason of which seems to be, because the Bones of the joints in them are very short; so that the same obliquity of the passages, which seems to be for this cause that they may not detract too much from the strength of the Bone in that part, was not so necessary here. There is no Membrane invests the sides of these passages; neither is the *Periosteum* on the outside, nor the Membrane of the Marrow within so kind as to communicate any part as a covering to them. They are most observeable in the Bones of the Joints, the *Ileum*, *Clavicles*, and the lower Jaw. The *Os Humeri* and *Os Femoris* have sometimes two or three; the *Radius* and *Ulna*, the *Focile Majus* and *Minus*, the Bones of the *Metacarp* and *Metatarsæ*, the *Ossa Sesamoidea*, and almost all the Bones of the Fingers and Toes, have commonly one; the *Ilium* has three, two on the inside, and one external: but I must confess, I have observ'd that Nature so little confines her self, either as to their number, or the particular place in the Bone where she forms these *Foramina*, that I can hardly say I have found them all alike in these respects in any two Skeletons that I have made the subjects of my enquiry. In their tendency these passages are more constant,

stant; and I have found that the Skeletons both of Men and Beasts do generally agree; so that where a passage runs upwards or downwards, the same *Foramen*, or that which answers to it, does in the same Bones of all such Skeletons commonly tend the same way, especially in the lower Jaw, the Clavicles, the Ribs and the large Bones of the Joints. In the *Os Humeri*, the *Tibia* and *Fibula* they run downwards: in the *Os Femoris*, the *Radius*, and *Ulna*, they pass upwards; so that we may observe that in those Bones which answer to one another in the upper and lower Joints, they have a contrary tendency; which there seems to be some reason for, because it is generally so, tho' it seems difficult to give one that may be satisfactory: that, which I have been thinking of, is the difference there often is in the position of these several parts with respect to the Trunk of the Body and the *Aorta*, the posture of the Cubit is frequently transverse to them, and the Thigh-Bones, when we sit, lie at Angles with the *Spine* and the great Artery; so that the reflection of the Medullary Arteries is better admitted here than in the Shoulder, which is more parallel; or in the Bones of the Leg, whose position is direct to the *Aorta*, where their course must have been perfectly contrary to it; tho' it must be confess'd that the
Cubit

Cubit and the Thigh-Bones are frequently posited in the same manner with respect to the Trunk of the great Artery. But I shall shorten my account of these observations, which it is hardly worth our time to insist upon. In the Lion, the Goat, the Antelope, the Rhinoceros, and the Bones of all other Beasts that I have examined, they ordinarily observe the same tendency as in Men, tho' in the Bone of the right Thigh, and the *Fibula* of one Rhinoceros they did differ; but in another they did exactly agree with what I had commonly observ'd in human Skeletons. In the Ostridge, and generally in all Fowls, these passages in all the large Bones of the Joints tend downwards.

From the superficies of the Bones, by the guidance of these passages, we come next into their Cavities (for the *Laminae*, which make the side or wall of the Bone, I have already given an account of), and we will first take a View of their internal or concave superficies, where the Cavity is large, and the internal *Lamina* lies fair to be seen. Here we have no streight Furrows nor superficial depressions as there are on the outside, and that because there was not the same, nor any reason to exact them, tho' on the inside of the *Cranium* (which yet, speaking strictly, is not the internal part which indeed is between the Tables)

bles) there are Furrows, but they are accidental, form'd by the turgescence and pressure of the Blood-Vessels, which therefore are not streight and parallel, like those of the outside of the Bones, but represent the branches of those Vessels that made the impressions. I have likewise, tho' rarely, observ'd the like on the inside of the large Bones of the Joints.

The Cavities are not all alike, but variously formed, obtaining a difference both in their figure and capacity, besides what the particular figure and magnitude of the Bones, in which they are formed, do oblige them to. They are of two sorts: the one are large, and they are single in every Bone where such a Cavity is formed; the other are little bony Cells, which are numerous, and make the spongy part.

The Bones which have the large Cavities, are the *Os Humeri* and *Femoris*, the *Ulna*, *Radius*, *Tibia* and *Fibula*, the Bones of the *Metacarpus*, *Metatarsus*, of the Fingers and Toes, and those of the *Os Hyoides*; to which we may add the lower Jaw, tho' the Cavity, compar'd with the magnitude of the Bone, hardly deserves to be stiled large; neither does it serve to entertain a Medulla, but only the Nerve and the Blood-Vessels: and the Bones of an Oxe's heart I have observ'd to have very large Cavities, that is in proportion to their bigness.
And

62 *Of the CAVITIES of the BONES.*

And when I ascribe large Cavities to any small Bones, as some of the Fingers and Toes, it is to be so understood; for there are some of those which I reckon amongst the small Cavities in some large Bones, will be found to be more capacious than those which I stile large in these.

In the *Os Humeri*, the Thigh-Bone, the *Tibia*, and *Fibula*, so in those of the *Metacarpus* and *Metatarsus*, the large Cavity, after it approaches towards their extremities, often begins to be divided by bony partitions, and to be occupy'd by some of the bony Strings, shooting from the Plates in the sides of the Bones in *Fasciculi*, and forming larger Strings, which do not produce any inclosed Caverns, but the partitions are open; so that they can not be called distinct Cavities: therefore I make all that part, so far as they appear, to be a part of the large Cavity. The *Fasciculi* proceeding from one side till they meet with others which are propagated from the opposite side, are united, so as to be so many continued Strings, as I have already shewn; and shooting forth laterally as they proceed, by a sort of Apophyses they are joined to those *Fasciculi*, which are parallel, and do in the same manner shoot out on their sides to meet them: from whence arises a texture, which represents a sort of *Cancelli*, or Lattices. Where
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these *Cancelli* begin first to be formed, the *Fasciculi* are very small and fine; when they approach near to the small Cavities, they grow larger. Here we may observe, with what caution Nature proceeds in detracting any thing from the side and solid part of the Bone: for the danger of a Fracture in these Bones being less, as the violence is offer'd nearer to the extremity, and so some parts of the *Laminae* accordingly can better be spared from the sides, therefore they are gradually diverted from it. We have not a whole Plate run off together at first, but only some minute *Fasciculi*, afterwards larger and larger, as they can be spared, till at last they are so large as to meet and be contiguous, and so are continued in the form of an entire Plate. The Interstices between the *Fasciculi* are many of them of a quadrangular figure, tho' there are abundance of them which have divers other figures.

Amongst these *Cancelli* are sometimes broad Plates, which are produced from the same Strings as that texture is formed of, when several of them run together in that order in which they lay before they ran off from the side of the Bone. These Plates are sometimes to be observ'd in the very middle of these *Cancelli*, at some distance from the side of the Bone: sometimes they are contiguous to it, where they recede from the Wall of the Bone
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in their proper form, and afterwards are divided into such *Fasciculi* of the Strings as that texture is made of; sometimes, after the large Cavity comes to be thus divided and occupied by the bony partitions of these Lattices, it opens again into a large Cavity, which is free from any such kind of texture, only there is something of it round about on the sides, and at the end of it the Strings run into this form again: but there is not much of this Lattice-work, before the Cavernous part or small distinct Cavities begin to be formed; but commonly, when the large Cavities come once to have the *Fasciculi* divert into them, and to be divided by them into little Interstices, this Lattice-Work is continued to the lesser Cavities, and when it approaches near to them, the *Fasciculi* grow gradually broader and broader, till they all meet in such a manner as to run together in the form of irregular Plates: and when they are thus met and united, they begin to make the little distinct Cavities, which first appear next the sides of the Bone, with some of the *Cancelli* still continuing in the middle. In the *Tibia* of a Horse I have observ'd this texture as fine and curious as in any Bones that I have examined; and I do not question but there is much of the same texture in Camels and other Beasts that are design'd for burthen, and where the reason, that

required

requir'd some particular care and contrivance to make them strong, did make it necessary to be cautious, and sparing in detracting from the solid part, and dividing that strength which was united in the sides before. In Cows there is little of this Lattice-Work, and that very coarse. In the Bones of those Fowls which I have examin'd, which have been of several sorts, I find nothing comparable to this texture, in those of the Joints which are large, and where it might be expected: there are indeed some large, bony Strings or *Fasciculi* of the small ones, running out from the sides into the Cavity; but they are commonly distinct and single, passing from one side to the other, sometimes obliquely, sometimes directly transverse, that they appear like little bony beams lying across, tho' sometimes some few of them run into the form of a Lattice. And without doubt these *Trabes* in Fowls answer to the Lattice-Work in some other Animals, and the use and design of both is the same; which I proceed to say something of.

The design therefore of these *Cancelli* is, in the upper part of the Bone, to sustain that part of the Marrow which fills the large Cavity; which in those Bones that are large, has a considerable bulk, but is suspended partly by the ramifications of the Blood-Vessels,

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and

and their continuation from the larger Mass of Marrow, into that which is lodged in the *Cancelli*, so running over and winding about the *Fasciculi*; partly by the Membrane of the Medulla, which is one continued Membrane through all the large Cavity, the Lattice-Work, and the small bony Caverns; so that though the Marrow in such a quantity is ponderous, though the Medullary Bags, and Glands are tender, and as well as the Blood-Vessels easily compressed; yet by this Providence the Superior part having a dependence upon the Strings in the *Cancelli*, cannot make a pressure upon that part which lies under it, so as to injure it. And therefore in the Bones of an Ox, where there has not been this contrivance, or but little of this texture, I have observ'd another thing almost equivalent to it; that is, a jetting out of some Plates like ledges or shelves, lying transverse, for the Marrow to rest upon in several places; sometimes in the middle, but mostly towards the extremities, where this Lattice-Work should be planted. At the lower end of the Cavity this texture is no less serviceable, where it bears off the pressure of the superior and incumbent part of the Marrow, from that which is lodged in its Interstices, and preserves it inviolated.

Before I proceed to give an account of the lesser Cavities, I shall inquire into the reasons
why

why the Bones of the Joints (excepting those of the Wrist, the *Tarsus*, the *Ossa Sesamoidea*, and the *Scapulæ*) and one or two more, have a large Cavity, and they seem to be two. First, the largeness of the Cavities was a consequence from what was necessary to be done, in order to make the Bones firm and solid. It is plain that the Bones, which are of any length, are in the greatest danger of being either fractur'd by any violent blow inflicted laterally, or distorted by too great a pressure made at their extremities, in those parts which are distant from their extremities; and therefore it was necessary that the structure of these parts should be such as would procure them the greatest solidity and firmitude which was not consistent with those distances of their parts from which the smaller Cavities arise; and therefore the Plates are so disposed there as to be contiguous: from which close application of one to another in the sides of these Bones there follows a large Cavity within them, which is more than equivalent to those lesser Caverns, which any other order or disposition of the *Laminæ* might produce.

Secondly, They were designed for some end; to wit, that these Bones might be capable of containing a greater quantity of the Medullary Oil: for being Bones which are frequently in motion, they require and expend

greater quantities of that oily matter than any of those which are not articulated; as they employ it not only for preserving themselves in a due temperament, and their security against that dryness which would render them more fragil, and does, as we find by experience, make them apt to crack; but likewise, with the help and mixture of a mucilage, to lubricate their extremities when they are moved; and to maintain them in a condition fit for their motions upon all occasions. For this reason 'tis that the Bones of the *Os Hyoides* have their large Cavities, because they are as frequently moved as we speak or swallow. And how evidently does the same reason appear in the Bones of an Ox's Heart (which, as often as I have observ'd them, have been two, and articulated) when they are continually in motion upon every Systole and Diastole of the Heart? There are, it is true, some Bones of the Joints which have not such large Cavities; as the *Scapula*, the *Rotula*, the Bones of the Wrist, and some others. Now for the *Scapula*, it cannot be said to be mov'd at the articulation: for tho' its situation is sometimes altered by its proper Muscles, yet at that end which only is articulated, it has the place of a quiescent Body, upon which the *Os Humeri* moves; so that, unless the *Scapula* had a Joint at its other extremity, so as it self to move upon another

another Bone, there was not this reason for the forming of a large Cavity in it. The *Rotula* is plac'd in a Joint where there is an Oil supplied from the large Cavities of three Bones, the Thigh, the *Tibia*, and *Fibula*, so that it cannot want a sufficient supply of it : for the Bones of the Wrist and *Tarsus*, they lie between such as have a considerable Cavity. Another thing which may be objected against what I now offer as one reason of these Cavities, is, that neither the *Os Occipitis*, nor the Atlas, which have a sensible motion, have such a Cavity ; nor yet the Ribs, which are moved so much in Respiration. For the two first, their motion is neither so frequent, nor ever so long continued as that of the Bones of the Limbs sometimes is, the Head being only now and then turned towards one side, or mov'd backwards or forwards ; and commonly it does no more than once incline to one of these postures, and afterwards returns into its more natural situation ; so that the expence of the Medullary Oil cannot be there so extraordinary. The Ribs are joined to the Vertebres by a *Synathrosis*, or such an articulation as is designed for an obscure motion. And to demonstrate the difference in their expence of this Oil in their motions, or the alteration of their position, let us consider how much the posture of the Bones of the Joints may be,

and sometimes is alter'd, and how little the Ribs in Respiration change their position. When any of the Bones from an extension are inflected, or from an inflection they are extended, that extremity which is remote from its centre, or the quiescent Bone, is sensibly moved circularly, or so as to describe part of a Circle: now by considering how much of a Circle this extremity makes in the Joints, and how little in the Ribs, we shall easily discover a difference in the quantity of Oil that they expend. I shall instance only in two, to wit, the *Tibia* and the Cubit: the first may be, and is sometimes so inflected, as to make above the fourth part of a Circle, and in ordinary incession about a twelfth; the Cubit so as to make about a third part; whereas the Ribs, so far as I can perceive, in ordinary Respiration are not moved above the fourth part of an Inch in that extremity which is remote from the Vertebres. Now some of the Ribs, without their Cartilage, are twelve Inches in length; but we must allow for their obliquity: and we will suppose the distance between the two extremities of a Rib to be, what it is in some of them, eight Inches, the Diameter of the Circle, in which the extremity, distant from the Vertebres, moves, must be sixteen Inches. Now suppose the Periphery of a Circle to the Diameter to be but

as three to one (though it is something more) then is the Rib in that part which is most remote from its centre, mov'd but the 192d part of its Circle: how insensible then must its motion be supposed to be at its Axis, or the quiescent Bone? Only I must confess they are more constantly in motion than any of the Bones of the Joints; and therefore the Caverns in these Bones are many of them of a long figure, and large for the simple sort, and at that end next the Vertebres they have sometimes a considerable Cavity.

Besides these large and more capacious Cavities, there are lesser Cells, and they are found in all the Bones: even those which have a large Cavity, have some of them at both extremities; which, where the *Laminæ* lie near to one another, are small; and as they approach nearer to a contiguity, grow less and less, till the Plates being plainly contiguous and united, they disappear. There are many of the Bones which have no other Cavities, as the Vertebres, Clavicles, the Ribs, the *Ossa innominata*, *sesamoidea*, and some others.

I have observ'd three sorts of these Cavities. First, there are some of them, especially in human Bones, which have the *Cancelli*; others are simple, or single distinct Cavities, which have none of that Texture; and a third sort likewise have no *Cancelli*, but are like

two or three, or more of this second or simple sort broken into one. These three sorts are generally different in their capacities; such as have the Lattice-Work being the largest, and the second kind the smallest of the three: neither is there a difference in their capacity between those of a diverse sort only, but of those which are of the same kind, some are larger than others. Nor do they differ less as to their figure than their magnitude: the first and last are altogether of an irregular figure. Of the simple small Cavities, some are exactly round, some oval; others a flat oval, some quadrangular; others, especially in the Ribs and Clavicles, are of a long figure: and in truth, to describe the variety, would be to give an account of all the figures that occur in the Mathematicks.

The small Cavities have all of them Pores or passages of communication, whereby the Blood-Vessels are propagated, and the Membrane of the Marrow is continued from one to another, and by which the Medullary Oil has the liberty of flowing out of the large Cavity into the lesser, and out of one small Cavity into another. But there is a great variety in the number of the Pores belonging to every such Cavity, even the second or smallest sort: in some there are only two, one for receiving, the other for transmitting; some of
the

the Cavities have three, or four, or more ; in which there is this difference, that some have several into one and the same ; others have a passage into several, or all the small Cavities that are next to them, by so many single Pores.

Where these small Cavities, and the porosity which arises from them, were consistent with the security of the Bones, that is, where there was no necessity to contrive in their structure that order which would give the greatest strength and solidity they were capable of, either because they have not so great a stress put upon them at any time, or because they are so thick and short that they are in no great danger of being broken ; and where the quantity of Marrow, which these small Caverns are capable of receiving, answers to the exigence of the part, as in those Bones which are not articulated ; in all these, Nature could without any danger or prejudice make their substance within all spongi-ous, and has chose so to do. So by lodging the Marrow in the small Cavities formed between the Plates, does intermix with all that part of the substance of the Bones that Medullary Oil which was necessary to preserve them from growing too dry and fragil : which was a more easy and immediate way to answer this end, than first to separate and deposite the Marrow in one large Cavity, and
after-

afterwards to supply it to the substance of the Bones by Pores, in that manner in which it is dispensed to those Plates whose contiguity and union renders a Bone solid.



Of the Blood-Vessels of the BONES.

I Proceed now to give an account of the Blood-Vessels of the Bones, which are, as in other parts of the Body, of two sorts; to wit, Arteries, which convey the Blood into them; and Veins, which serve in the reduction of it to the Heart, after it has paid a Tribute of some certain Particles to those Glands which it touches upon in its circulation. And both these may be said to be of two sorts; that is, they are assigned to two several parts: some to the Medulla, and others to the substance of the Bones, in order to their Accretion and Nutrition.

The Medullary Blood-Vessels will fall more properly under our consideration when I come to treat of the Marrow: I shall therefore

fore defer the particular notice of them till I come to speak of that. As for the nutritious Arteries, there are several of them belonging to a Bone, and every one of them that I have observed, enters the substance of a Bone at a distinct *Foramen*; only I once met with two, which made their entry by the same passage. The most considerable of them enter at one end of the Bone, and the contrary to that where great numbers of the Veins have their exit; and in the large Bones of the Joints, where they are most obvious to our observation, they plainly enter at that end which is next the Trunk of the Body, excepting in the *Scapula*: and because they are Arteries, they do not alter the colour of that part of the Bone; which therefore is whiter than the other extremity, or where ever the Veins, which are red and more numerous, do pass out. From that end of the Bone, at which they enter, they have a tendency towards the other extremity. Some of these I have seen running amongst the *Laminæ* in the most solid part, and where the Plates have been contiguous, and traced them a considerable way together; observing them to be sometimes conspicuous, and indeed large, considering the close union of the Plates, and the solidity of the part that they passed thro': and in any part of a Bone, whilst it is Cartilaginous

laginous, they are plainly to be observed, and more easily followed. Now though in some parts of the Bones there is little, and in some no appearance of Blood-Vessels, yet that they are in the whitest part of a Bone, does evidently appear in the examination of any part of one that is yet Cartilaginous; and that they are very numerous, I have found some reason to believe, from a considerable *Ecchymosis* I have met with in a solid and perfect Bone, in that part which seemed to have been naturally white, and to have given as little suspicion of such a thing, as any part of it.

The Nutritious Veins, if I may so call them, that is, those which convey the Blood back from the Nutritious Arteries of a Bone, are very Numerous; not throughout the whole, or in every part of it, but where the Arteries terminate: for as they do not pass through the same *Foramen*, so neither do they keep such a sociable course as to run one by another in the substance of a Bone, as they often do in other parts. This was neither necessary, nor convenient: Not necessary; because the design of the Veins being to carry back the Blood to the Heart, so long as they conveniently answer that end, it is sufficient, let the course in which they proceed be either this way, or that. It was not convenient; for as there appears in the structure of these parts a
provi-

providence, studiously contriving what was necessary for their firmitude, and ordering whatever was requisite to be done, and might be injurious to it, in such a manner, as to make one consistent with the other; so here, that the passages, by which the Nutritious Blood-Vessels are disseminated, might not be too large (which we may reasonably suppose they would have been, if they had been so capacious as to give a passage to the Vein and Artery together) where ever any of the Nutritious Arteries terminate, be it about the contrary extremity to that where they enter, or in some intermediate part, the Veins which succeed to them, instead of running along by the Arterial Channels, and continuing their course within the substance of these solid parts, pass out immediately at their superficies; and their passage in the solid part of a Bone is so short, that vast numbers of them, if not all, seem to be at their exit out of the bony substance, single Veins, continuing distinct from the extremity of those small Arteries they serve to; that they never come to fall into any common Channel before they arrive upon the surface of the Bone, which I do suppose from their Number and the minuteness of them.

Some



Some Observations on the TEETH.



ALTHO' the Teeth are of the Classis of Bones, yet having some Things particular, I shall give a distinct account of some few observations I have made of them; and they consist of two different parts, of a diverse substance; the one is of the nature of a Stone, the other is truly bony.

The first may well be said to be Stone, when it has the hardness of Stones, the solidity of Flints themselves, so as in the same manner to resist the impressions of the Saw; and has besides something of a shining or glittering brightness, as the hardest of Stones have; tho' after all it must be confess'd that it is often eaten away, and will be dissolv'd in *Aqua fortis*, which Flints will not; which, as it shews us how injurious strong acids are to this part, may direct us to the use of better means for whitening the Teeth, than Spirit, or Oil of Vitriol, or any thing of that nature.

This

This I call the *Cortex* of a Tooth, and is plainly and easily to be distinguish'd from the other part. The several parts, or *striæ*, of which it consists, differ in their position from the Strings in the bony part; not lying streight in the length of the Tooth, but on the sides oblique, near to a transverse position in some Animals; and upon the upper part of the *Dentes Molares*, where the bony strings are transverse, and at the very point or extremity of the sharp Teeth, they are in a manner erect. The figure of these *striæ* in the Teeth of some Animals is streight; in some a little, and in others more oblique, as in those of Men, in which I have observ'd them to have the similitude of a Bow; the convex part of whose Arch on the sides lies obliquely downward, and the concave upwards, with the lower end planted and fix'd upon the side of the internal or bony part, which gives them a Basis to rest upon; so that when any thing presses upon the other extremity, they are in no danger of being protruded out of their place, having so firm a Foundation to stand upon, and being so disposed that all impressions are made not laterally, but at one end of them, and so as to make the greatest advantage of their Basis, in resisting that force which might move and disorder them.

Considering the Teeth are designed for the breaking and dissolving the parts of our solid food, the reason does appear, why that part which stands out of the Gums, and is the immediate instrument of Mastication, should at least be cas'd with a hard and stony Cortex, otherwise they would be more easily injured by their action, and sensibly worn away. It is true, some other Bones are rubb'd one against another at their articulations, where they are of a more soft and tender nature, without any sensible injury; but then there is a continual supply of an oily and mucilaginous Matter, which prevents their attrition, which neither the position nor the Office of the Teeth does admit.

When a Tooth is broke, and this stony part is viewed with a Microscope, it represents almost a Saw, or rather the inequalities and notches of such a Grater as is made to some Steel Tobacco Stoppers, excepting only the obliquity of the *striae*; so that the parts, or (which I am apt to think it consists of) the *Laminæ* of it are form'd with such inequalities, that they are applied and joined together by the way and in the manner of a *Suture*; the Teeth or ridges of one lying into the notches of the other.

This part does not seem to be allow'd any share of that medullary and oily substance
which

which is supplied to other Bones, and is not wholly wanting to that part of a Tooth which is truly bony. For besides that I could never discover any thing of a moist or oily nature insinuated into it, nor observe any thing of an Oil to sweat out of it, either in a Skeleton, or when it has been extracted from one living, it would be so far from doing any service here, and preserving the natural temperament of this part, that it would be more apt to destroy it, as it is; and ought to be extremely dry and hard, and seems to have something peculiar in its nature and constitution, which preserves it from being fragil or friable, without the assistance of any oily matter. And whether that *Mucus* which is found sticking upon the Teeth, is supplied from within, and passes out of it, is to be much question'd; and it seems rather to be some *viscous*, or *gummos* and terrestrial parts supplied from the *Saliva*. And however a Tooth is thought to grow beyond its natural length, when its opposite is wanting; yet this is not so certain as not to admit a dispute. I have observ'd that in some Teeth, when those which stood against them have been gone, there has been no elongation. And if it were so that a Tooth took an occasion to increase its length from the want of that which was opposed to it, and of that pressure which it made upon

it; why do not the Teeth continually protrude their lateral parts, and acquire an extraordinary thickness in that part of the Cortex, where there is not the pressure and opposition of another Tooth to hinder it? That therefore which seems to be an elongation, may rather be thought to be the protrusion of a Tooth from an extravasation, and the pressure of some nutritious juice flowing into the Socket; as we find, after a Tooth is extracted, the *succus nutritius* of the Jaw is thrust forth into the Cavity, and fills the *Alveolus* with a bony substance. Or if the Tooth does afterwards grow, and exceed its ordinary length, the addition that is made to it does not seem to be in the *Cortical* part. It is true, we cannot well imagin that so thin a substance, as hard as it is, should serve a Man his whole life time without a reparation; so that we must suppose, as some of the parts are worn off, they are renewed. But when the Teeth, as well as other parts, have a certain and convenient magnitude prescrib'd to them, and the solidity, especially of this *Cortical* part, fixes the limits of its increase more firmly, and makes them more immoveable than they seem to be in any other part of the Body; I cannot think that the stony Cortex has any preternatural increase after the opposite Tooth is gone.

This

This stony Case or Cortex in Men, the Lion, and other Carniverous Animals, covers all that part of every Tooth which stands out of the Gums; but when the Teeth come to be protected by them, it grows thinner, and quickly terminates: neither was it necessary that it should be so thick and strong where it is covered so as not to be exposed to that violence and those impressions which the naked part so often meets with. In the *Dentes incisores* and *Canini*, both of Men and Beasts, all that part which stands out of the Gums, is cover'd with such a Cortex; but in the *Dentes Molares* there is a great difference: For in Horses, Sheep, Goats, the Antilope, the Rhinoceros, and such Beasts as live upon Grass and Corn, the basis, or that extremity which lies out of the Gums, is not cover'd with it, but only the sides, and it runs to that extremity, where it ends in a sharp edge; but sometimes there grows over it a bony crust: and whereas in Men and Carnivorous Animals there is none of this stony substance within the bony part, it is otherwise in these Animals, in whose Grinders there is the same sort of substance within mix'd with that part which is bony, and that in several places, which rises up likewise with an edge above the bony part, and is often continued to the extremity of the Roots. And there does evi-

dently appear a contrivance of Providence in the formation of these parts in several Animals, accommodating them to the nature of the Food which the Animal lives upon. In Men, whose Food is generally soft, and more fit to be broken into pieces by compression, than to be ground, they are obtuse: In the Lion, Tiger, Dogs, and such Creatures as eat Flesh, but are frequently entertained with no tenderer Food than Bones, tho' they are cover'd with a stony Cortex, they are sharp with several points. In those Beasts which are maintain'd by Grass, Hay and Corn, this stony part rises up in several places in ridges, with a kind of edge, and does answer to the inequalities of a Millstone. In Hogs, that eat Flesh, as well as Grass and Corn, they are cover'd with a stony Cortex, but formed in such a manner as makes them of a middle nature, and fit for the mastication of both.

Underneath the Cortex in human Teeth and other Carnivorous Animals (and within the same stony substance in other Beasts) and within the Gums, is another part of the Tooth which is truly bony. And this Bone (for so I may lawfully call it) consists of *Laminæ*, as other Bones do, which I have plainly observ'd and distinguish'd in a Horses Tooth.

From the different nature and solidity of these two parts of the Teeth is the reason evident, why they are often so hasty in their decay, when the external or stony part is once broken off; that they quickly grow rotten and hollow, when the Cortex, which is much the thinner part, endures so many years, and is daily employed without any sensible detriment: and upon this account it is, that when the Gums are eaten away, so that some part of a Tooth which is not defended with a stony Cortex, is laid bare, it is eroded; when that part that naturally stands out of the Gums, and is by such a solid substance secured, suffers no such injury.

The Teeth have all of them in that part which lies within the Gums, a *Periosteum*; but not that Membrane which is common to the other Bones: for that, which immediately invests so much of them as is covered with a Membrane, is not a continuation of the *Periosteum* of the Jaw-bone, but is united to, or rather propagated from that Membrane which covers the Gums, and is common to the whole Mouth, which does not terminate with the Gums; but when it comes to their extreme edge, turns in, and is reflected between the other side of the Gum and the Tooth: then it descends into the *Alveolus*, and adheres immediately to those parts of the Teeth which

lie within. With the Membrane in some Teeth is communicated to their Roots, especially in the upper Jaw, some part of the hard and fleshy substance of the Gums, by which the Teeth are fastned more firmly in their Sockets: and because they are parts which ought to be firmly fix'd, there is the same contrivance for the strong adhesion of their Membrane, as in other Bones, to wit, inequalities or superficial Cavities, which inlarge their superficies. In Men they are often depressions or Pits of an irregular figure, tho' in some human Teeth there are circular Furrows, which are considerably wide. In the Teeth of the Rhinoceros I likewise find broad and circular Furrows. In the Teeth of a Tiger these inequalities are also Furrows, which are remarkable and numerous, but they are streight, and run from one end of the Tooth towards the other.

But tho' the Teeth themselves have no part of the common *Periosteum*, yet it comes very near them; for the Sockets, in which they stand, have it: the *Periosteum*, which covers the Jaw-bones, running to the edges of the *Alveoli*, or Sockets, turns into those Cavities, being on one side contiguous to the Bone, and on the other to that fleshy substance which helps to fasten the Teeth more firmly: and where none of that hard flesh intervenes, it
does

does coalesce with the Membrane, which does immediately cover that part of the Tooth that lies within the Gums, and they make, as it were, but one Membrane.

There is one thing particularly remarkable in the Teeth, which other Bones do not seem to pretend to, and that is, Nerves. The reason of the difference seems to be chiefly, if not solely, for the sake of that part which is destitute of a Membrane; and to answer for the want of the *Periosteum*. Tho' the design and use of the Teeth would not admit of a Membrane in that part which is immediately employ'd, and does act in Mastication, yet it was necessary that should have an influx of spirits to assist in its accretion and nutrition; whereupon the Teeth have every one of them a Nerve that supplies them to this part. The Nerve which runs along in the Jaw, and from whence the Nerve of every particular Tooth is propagated, is plainly a *Fasciculus* of other lesser Nerves, which I have found to be more in some than in others: sometimes they have been sixteen, sometimes twelve; and in a human Jaw I once observ'd no more than seven. But all these smaller Nerves are divisible into less, till at last they resolve into minute Filaments. The *Foramina*, by which these Nerves pass into the Tooth, are visible with the help of a magnifying Glass, and

many times without it; and there is always one to every Root; and in a Tooth which has had only a single Root, I have met with two passages, one on each side; and the *Fq-ramen*, where it is single, is not always formed at the very extremity of the Root, but very often a little on one side,





THE SECOND
DISCOURSE,
 OF
 ACCRETION,
 AND
 NUTRITION.



THE next thing which I am to speak of, is the manner of the Bones Accretion and Nutrition; which, as indeed the growth and nourishment of all the parts of the Body, are hard to be understood and explain'd. That Accretion is by the addition or apposition of new matter; and that Nutrition is a reparation of those parts which are continually expended, are accounts that are

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are easily given, and as easily understood. But how the nutritious Particles are separated and supply'd; how they are proportionally dispensed to all the solid parts of the Body, and regularly disposed of; how Accretion is performed in young Animals till they grow to a convenient and the ordinary magnitude of their own Kind; and comes to cease, after the dimensions of the Animal are carried to the common and natural limits set to every Species, are not so easy to be explicated. However, I have made some essays: and although some unlucky objection or other has made some thoughts I have had about this Argument, miscarry; yet I have formed and considered of one Hypothesis, which gives me some satisfaction, and even the confidence to expose it to the objections, and to submit it to the censure of great Philosophers and better Judges.

To compleat an account of Accretion and Nutrition, there are three things to be considered and explained: The first is, the manner how the nutritious matter is supply'd and apponed to the parts of younger Animals, so as to give an increase to their dimensions: The second is, what it is that puts a stop to this in a convenient time; or how it comes to pass that Accretion ceases when the Animal is grown to a due magnitude, and the ordinary limits

limits that are prescribed by Nature to the Species which it is of: The third and last thing to be enquired into, is, what Nutrition, taken strictly, is, and how it is performed. All which I shall do at large, as it concerns all the parts in general; and then I design to give an account of the growth and nourishment of the Bones in particular, from the general Hypothesis; which will lead me to the consideration of some morbid affections of the several parts where their nourishment is particularly concerned.

I shall not go about to mention or object against the Philosophy of others, about these appearances, but only offer my own thoughts, and take my own method to explain them; only where any thing that is plausible, and stands in competition with my Hypothesis, occurs, I shall be so natural as to endeavour the defence of what my own Thoughts have brought forth.

I shall begin first, and explain the manner how the parts in young Animals are nourish'd, so as to be extended in all their dimensions. And first, the nutritious Particles are supply'd from our daily Aliment, assuming, after Concoction and a due separation of the purer from the more gross and feculent parts, the form of Chyle; which through the Lacteal Vessels passes into the Blood, taking in its way a juice
from

from the Lympheducts, in which there seem to be many of the luxuriant Particles of the *Succus nutritius* of the Glands, from whence they arise; which communicates some nutritive parts, and improves the nature of those in the Chyle which are design'd for nourishment: and after this milky juice comes into the Blood, and arrives at the Heart, the parts which are to make the nutritious juice, and are as yet imperfectly Concocted, are there so broken and attenuated, as to be adapted to the Pores, which are to separate them from the Mass of Blood, and disposed for a separation; after which they are conveyed by the Arteries to all the parts. That the nutritious juice is supplied from the Mass of Blood, is supposed and granted by the greatest part, both of Speculative Philosophers and Physicians; and therefore I need not trouble myself much to prove it, or argue for it; only I mention this, to give a more perfect account of what we are now concerned about, and to trace our nourishment from its first original. I know there are some would cast this thing upon the Nerves, who plead the observation of an Atrophy, which often attends the parts that are paralitick, to prove it. And I confess they have a plausible Argument from it for their Opinion, and it may seem to press hard upon that which is more commonly receiv'd
when

when they argue thus; that the part, which is affected with a Palsy, is often imminished, tho' there be a Pulse and an influx of Blood into it. Now if the nutritious Juice be supplied from the Mass of Blood, how should a part, that is paralitick, want it, and decrease in any of its dimensions; when the Blood, in which we conceive the *Succus nutritius* is contained, continues its influx into it? But an obstruction of the Nerves we all allow in this case: and as the influx and supply of the nutritious Juice is rationally to be supposed to be cut off by those obstructions; so we must conclude that it naturally flows in those Channels where the obstruction is made, that is, in the Nerves. I shall not stand now to answer this Objection; but when I have offered my thoughts concerning the manner of Nutrition, I shall shew, how according to my Hypothesis an Atrophy may be the consequence of a Palsy, tho' the nutritious Juice be naturally conveyed by the Arteries to the several parts, and with the other sanguineous parts continues its circulatory course in the arterial Channels of that part which is Paralytick, and labours at the same time with the symptom of an Atrophy.

Secondly, Though the nutritious Juice be contained in the Blood, and supply'd from it, it is not the whole Mass of Blood, nor any portion

portion of it indifferently, that is fit to be united to, and to give an increase to any parts of the Body ; but they are a peculiar sort of Particles, that are every where dispensed for this end ; such as will form a substance of the same nature, which the part that they augment, is of. And this Juice not only is different from other humours, both those that are excrementitious, and such as are otherways useful ; but we have some reason to think that there is a difference even in the *succus nutritius* it self : for where the Nature and Constitution of one part are remarkably diverse from them of another, as in the Bones and Fibres, there the nutritious Particles seem likewise to be different.

How far the difference lies between the muscular, membranous and vascular parts, I leave to others to inquire, to better and nicer judgments to determine : though I cannot but say I do conceive that there is no difference in the *succus nutritius* of these parts, only in the manner or order in which the Particles of it are disposed in their opposition ; since, as it is commonly known, in Issues and about the edges of them, the nutritious Juice of the Skin does often produce fleshy Excrescencies ; such a Flesh as is different from the nature of the part which it is to nourish. And although the Excrescence from thence made, be different

rent from the Skin, yet it is certain that it is from the *succus nutritius* of the *cutis*; since the *solutio continui* is made in that part, upon which the nourishment, after it is separated by the nutritious Glandules, extravasates, and by sticking round the edges of those *Foramina* by which it issues out, lays the Foundation; and by the gradual addition of it self, raises the Structure of those Excrescencies. It cannot be thought to be the nourishment of the fleshy parts, distinct from that of the *cutis*; for the wound inflicted does not reach so deep as to set open the *Canaliculi* of the fleshy Fibres, and to give a preternatural passage to their nutritious parts: but in Men there intervenes the *Membrana adiposa* between the *cutis* and any thing of Flesh, excepting in the Lips, and two or three places more.

Be there a difference or not, it is always gelatinous: and this not only our reason persuades us, as it is requisite it should be so, to dispose it to adhere and unite to the parts; but there is that sometimes which seems to demonstrate it to our very senses, I mean in Ganglions, where the material cause of the Tumor is rather the nutritious Juice of the nervous or tendinous parts extravasated, than any preternatural humour or matter. For altho' I do not suppose that the *succus nutritius* of the Body is from the Nerves; yet they
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have, as other parts, a supply of it for their own nourishment, which I take to be all the *succus nervosus* that they have. Now the matter which is collected in these swellings, is always a sort of Jelly, which may help to inform us what the nature of the nutritious Juice is.

Thirdly, The Particles which serve for nourishment, are separated from the rest of the Mass of Blood, before they can assume the distinct and proper form of a nutritious Juice, or be employ'd in the augmentation of the parts. For if we suppose that they are supplied and cast upon the parts immediately by the Blood circulating thro' them: if we imagin, according to *Diemerbroek's* notion, that the nutritious Particles, as being a part of the sanguineous Mass, and circulating thro' the whole Body, are by the power of their motion driven against the sides of the Vessels which contain that Mass of Blood, and striking into the Pores, stick there; and as one end of the Particles thus driven in, fills them, so the other extremity which stands out, forms another Series of new Pores for the infixation and union of new parts: I say, if we take up with this Hypothesis, then we must make the Blood immediately to wash every part that is nourish'd; so that either Nutrition must be monopoliz'd by the Veins
and

and Arteries, or we must grant an extravasation of the Blood, so as to touch upon every single Fibre that is nourished in its circulation ; which will be to make the whole Body to consist of nothing but sanguiferous ducts, besides other Objections, which I shall not stand to mention.

Fourthly, This separation of the nutritious Juice is made by Glandules, or glandular Pores, which may properly enough be termed Glandules, as they serve for the same Office, to wit, Secretion. These nutritious Glandules we cannot suppose to be generally placed at the extremities of the Arteries : for, besides that we cannot upon this supposition conceive how every Fibre, and every part of that Fibre can have the nutritious parts supplied to it, it is impossible it should be so in the Glands, where the extremities of the Arteries are occupied by Glandules of another nature, that separate another kind of liquor, and such as is evidently not designed for the nourishment of those parts. As to instance only in the Kidnies, it is plain that at the extremities of the arterial Vessels in these Glands are plac'd the Glandules which serve for the separation of the urinary *Serum* ; so that there is no convenience for the situation of other distinct Glandules ; and those which are there seated being the colatory parts that separate an ex-

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cremen-

crementitious humour, cannot be thought to be the Organs that separate and supply the matter that nourishes them. Therefore I do conceive, and I think, not without very good reason, that there are Glandules, or particular Pores adapted to the figure of the nutritious parts which are to pass thro' them, formed in the sides of the Arteries, every where as they proceed, almost in the same manner as the Glandules are seated in the small Intestines, by which the Chyle is separated from the *Fæces*, and penetrates the Guts into the lacteal Vessels: only there is this difference, that the lacteal Glandules are planted along the small Guts but on one side of the Canale, whereas those that serve for Accretion and Nutrition, are seated on every side of the arterial Channel, and supply a *succus nutritius* to all the Fibres and other parts which lie immediately round about, or very nigh to them. Now as we cannot suppose that any of these Glandules are seated at the extremities of the Arteries in any of the Glands of the Body; so the situation I ascribe to them, makes them consistent with other Glandules in the same Artery, so that we may easily apprehend how the same Arteries, which serve to the Glandules that separate the particular humour of that Gland, serve also for the supply of that Juice which nourishes it; as it is made no matter of doubt

doubt, but they are the same: and not only so, but this situation is more convenient for the separation and supply of the *succus nutritius* to the whole Body, if it be not that, which only can answer this design of Nature.

And now I am speaking of the separation of these Particles, pardon the digression, if I suffer my self to be led a little by this occasion out of the proposed method of my Discourse, to consider the manner in which glandular Secretion is performed; which being explained, will help us to understand how not only this, but all the Humours which Nature extracts from the Mass of Blood, are separated.

It is true, there is a diversity in all Glands, that separate a different Liquor; but yet there are several general things in which they all agree, so far as their Office is Secretion, without a respect to the particular Liquors which they seern.

To what I am going to say concerning this great affair of Nature, I must premise that natural Law of Motion, that all Motion in its own Nature or proper tendency is direct from its Centre, or *terminus à quo*: or to use the great Philosopher *Des-Cartes*'s own words, speaking of Motion, *Altera lex Naturæ est; unamquamque partem materiæ seorsim spectatam non tendere unquam, ut secundum ullas lineas obliquas pergat moveri, sed tantummodo*

secundum rectas; and that it never does but from some opposition, and the occurrence of another Body, either fix'd, or differently moving, incline to an obliquity; and even every Body that is moved circularly, does endeavour to recede from the Centre of that Circle which it describes. And altho', when a solid Body, being in motion, meets with another, which has a greater power to stop it, than that has to persist, it is reverberated; yet there are some Bodies which are not in their own Nature so fit and ready to be reflected, as those which are viscous, soft, or fluid: and be they solid or not; yet when there is a continuation of matter which from the *terminus à quo* presses them on with a greater force than what they have to recede with, so long they will not be reflected, though there lies a resistant Body in the way of their direct Motion: but if there are any lateral and oblique passages, they will continue to move on that way which offers it self fairest for, and comes nearest to the line of their direct motion.

Now for the particulars, wherein the general agreement between all Glands lies, they may be reduced to these Heads.

First, All Glands have their *Vasa Adferentia*, or Vessels, to convey to them that Mass from which the Particles, or that particular humour which they separate, is extracted.

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These Vessels in those Glands which separate any humour from the sanguineous Mass, are commonly Arteries, tho' it cannot be affirmed that they are always so: for in the Liver, it is known, that the bilious Juice is convey'd in the Mass of Blood to the Hepatick Glandules by Veins, the *Vena Portæ*, and the branches of it, which belong (to use the old term) to the *Parenchyma* of that large *Viscus*; but generally they are of the arterial kind: and such are the Vessels which carry the Blood and the nourishing parts contained in it, to the nutritious Glandules; only in the part I now mentioned, as the *Vena Portæ* does perform the Office of an Artery to the Hepatick Glandules, so I do conceive it has the same sort of nutritious Glandules as the Arteries every where have, formed in the sides of it.

Secondly, To these Vessels, be they Veins or Arteries, belong small Glandules, or secretory Organs, which seem to be formed from the exterior Tunicle of the *Vasa adferentia* expanded, and in a peculiar manner modified: and that the *Vena Portæ* might have a Tunicle to spare for this end, it has a Coat extraordinary, immediately communicated from the Membrane which cloaths the Liver. From hence we may have the reason, why the Veins have fewer Coats than an Artery, because where the one terminates, and the other arise,

there is one Tunicle taken off, for the formation of the Glandules, which for the most part are placed at the extremities of the *Vasa adferentia*, whether they are Arteries or Veins; yet not so universally, but that where it is more convenient, or rather necessary for accomplishing the ends for which the Juice is designed, they are seated on the sides of these Vessels, as those that serve for Accretion and Nutrition. They are always so seated as to be exposed to the appulse of the Blood, that like a shoar they have the Waves of this Red Sea continually beating upon them; and they stand so as to favour the motion of the Particles that they are to discern, and their tendency in a right line, at least more than the Vessels which the residuous Mass continues its course into. This is evidently so in those Glands in which the Glandules are seated at the extremities of the *Vasa adferentia*. For as soon as the Blood is arrived at those extremities, it is reflected: the Vessels, thro' which it is afterwards to continue its motion, run commonly directly contrary to the course which it held in the Vessels that convey it to the Glandules: so that when the Blood is come to the extremities of the *Vasa adferentia*, the motion of it afterwards, and its progression into the venose Vessels, which convey it back to the Heart, do not answer to its natural tendency;

dency; whereas the Glandules are conveniently situated for favouring the direct motion of the Particles which they are to separate; and thereupon the Particles of the Liquor, which they fecern, do naturally, or in obedience to that Law of Motion, respecting its tendency which I first mentioned, press upon them, and endeavour to proceed into them. And how this assertion, that the situation of the Glandules is so contrived and ordered as to favour the tendency of that matter which they fecern, more than the Vessels which carry the Blood back to the Heart: I say, how this holds true in the *Glandulæ Nutritivæ*, I shall presently shew.

Thirdly, These Glandules have Pores or Passages, by which they receive the Particles which they are appointed to separate. In this all Glands do necessarily agree, that their Glandules are perforated on that side where the Blood beats directly upon them; which Perforation is their secretory Pore: besides which they have another, whereby they discharge and empty themselves commonly into Ducts, which meet in one common Receptacle; tho' there are some Glandules that seem to evacuate themselves by their exoneratory Pore into the Mass of Blood.

Fourthly, at the termination of those glandular Pores, by which the parts of the Li-

quor, produc'd by every Gland, are separated; or on that side which lies next to the small Cavity of the Glandules, there seem to be Valves, or such a Formation as is equivalent to them. For altho' the Glandules themselves are so seated, that the Particles which are separated by them, when they strike against them, and the passages are clear, and obtain their natural figure, cannot but in obedience to that natural Law of Motion I have taken notice of, advance into them; yet we find that the particular Ducts leading from the Glandules to the Receptacles, or any large conveyances, run in several Glands plainly contrary to the course of the Arteries, so as sometimes to make a sociable progress with the Veins, at least for some way; so that the course of these Ducts is as contrary to the natural tendency of the Particles which they convey, as that of the Veins is: as to instance again, in the Kidnies, there autopsy it self does tell us, that the *Tubuli urinarii*, which carry the Urine to the *Pelvis*, after it is separated by the *Glandulæ Renales*, run as contrary to the course of the Arteries, and the tendency of the urinary *serum*, whilst it is moving thro' those Arteries with the other parts of the sanguineous Mass, as the Venose Vessels do: and therefore when the Particles that are admitted and separated by the glandular

Pores,

Pores, are once entered into the Glandules, they have no farther to go in a line more direct and agreeable to their tendency, than if they were carried into the Veins: but the tendency of their motion must necessarily be alter'd by the variation in the course of those Ducts; and being obliged to a reflection, some of them might regurgitate into the Artery, if there were not *Valves*, or such a contrivance in the secretory Pores, as not only makes them capable of giving the Particles they are to separate, leave to enter, but denies them likewise the liberty of returning.

I know there is one thing may be objected against it, to prove that it is not necessary there should be *Valves*, or any thing like them; and that is, that the continual succession and impulse of new matter is a sufficient provision against the regurgitation of any Liquor or Particles of it into the Blood, by those glandular Pores which had before separated them: for the Particles which are already separated, seem to be obliged to proceed from the Glandule into the Duct, from the continual pressure and protrusion of those parts which come immediately after them.

But Secretion being the grand affair of Nature, upon which not only our Health and Wellbeing, as we are Animals, but our very Lives do depend, it must be thought in a business

business of so much importance she has taken care for carrying on that great and necessary Work, by giving the part, in which it is to be performed, all the advantages in its Structure which it is capable of; especially when we consider, that tho' there is in the Veins and Lymphatick Vessels the same reason to make such a contrivance unnecessary; though there is the continual influx and succession of the humours, which they convey, to propel any parts of that matter which had before enter'd into, and are moving in the Channels of those Vessels; yet we find that they have their *Valves* to hinder the regurgiation or reflux of the Blood and *Lympha* in hem, and to promote their progressive Motion or Circulation, and that even where they are streight, and there is nothing in their course to alter the tendency of the humours, and to dispose them to a reflection: nay, even in the Heart, at those passages into the *Arterii Pulmonaris* and the *Aorta*, where the pressure of the subsequent Blood upon that which flows immediately before it, is more violent than in any other part of the Body, Nature has not thought the succession of one part of it to another, and the power which one has to propel the other, an infallible remedy against the reflux of that which is already thrown into those Vessels: but to make the progression

sion of it more certain and necessary, has planted at the passage out of the Ventricles those strong and remarkable *Valves* which we call *Semilunares*. How then can we think that the Glands, which serve (especially some of them) for great, and necessary uses, that stand at a greater distance from the Heart, and consequently have a less violent appulse of the Blood, and where one part of the Liquor, which they separate, make a more languid pressure upon another, should be destitute of this advantage?

Fifthly, and lastly, To the Glands belong also Blood-Vessels, designed for carrying off and conveying back to the Heart that part of the Blood which had not the liberty to enter into their Glandules.

The impediment, which hinders the progress of those parts of the Blood, that return by these Vessels into the Glandules, is twofold, one is necessary, the other contingent. That which is necessary, lies against those Particles which are not in their figure adapted to the glandular Pores, or are of such a magnitude as renders them incapable of entering into them: That which is accidental, prevents the ingress of many of those Particles into the Glandules, which are both in figure and magnitude adapted to their Pores, and of the same nature as those, which at the
same

same time are separated by them: where it is not, because the Glandules in themselves are incapable of admitting them, that they pass by them into the reducent Vessels; but from the anticipation of other Particles of the same kind, occupying the mouths or Pores of the Glandules in that instant when they are ready to enter; for the Blood being naturally in the hurry of a rapid motion there is no such thing as stopping, or expectation in the Artery; so that it is impossible but some Particles should slip by the Glandules which ought to separate them, whilst others are in the passages. And hence partly it comes to pass that the Blood, after so many Circulations and the Secretions performed in those Circulations, does still supply to all the Glands those Particles which they naturally secern, without a continued succession of Chyle; as partly from the comminution of some parts, whose magnitude, before they are farther attenuated by the Heart and Spirits, renders them incapable of penetrating the glandular Pores.

The Vessels which carry off the residuous Blood in the *Viscera* and other Glands, after it has paid a Tribute to them, are the Veins; and the same kind of Vessels do perform this Office to the nutritious Glandules, but not so immediately: for they not being seated at the extremities, but in the sides of the Arteries, the
Blood

The manner of GLANDULAR SECRETION. 109

Blood does not so soon as it has supplied some of the nutritious Particles to the Glandules, presently shift its Vessels, and flow into the Veins, but continues its course in the Artery afterwards. So that it is the Artery that does immediately convey the Blood from these Glandules, unless there are any of them placed at the extremities of the Arteries in some parts, as it is probable there are in the Nerves and Muscular parts, and in the substance of the Bones, where those extremities do not seem to be occupy'd by other Glandules: but yet at last, the Blood, when it has passed by all the nutritious Glandules in an Artery, is received and carried away by the Veins.

From what I have said concerning the general agreement of all Glands in their structure, and the Vessels belonging to them, and the Law whereby all Bodies, that are mov'd, are directed in their natural tendency, we shall find it no difficult thing to conceive how all the humours of the several Glands are separated, and to explain the manner of glandular Secretion. As for that separation, which is made by the Glandules of the *Viscera*, and wherever they are seated at the extremities of the *Vasa Adferentia*, there is this account may be given of it, to wit, that the Blood being carried with a quick, and violent motion to the extremities of those Vessels, which supply

supply it to the Glands, all the parts of it are there endeavouring to proceed in a right line, and with this endeavour they necessarily press upon the secretory Organs which are there placed; which being seated in the way of their motion, and so as to favour their tendency in a more streight line than the Veins, which run contrary to it, they are continually importun'd by their pressure to entertain them, and all the Particles of the Blood, if they could have the liberty of continuing their motion in that line which they endeavour to proceed in, would more readily proceed into the Pores of the Glandules, than be reflected into the Veins. But altho' there is an appulse and a pressure of all sorts of Particles in the Blood against these Glandules, it is not possible they should all of them continue their motion into them, so long as the Glandules enjoy their natural tone, and their Pores obtain their proper figure; they are only those, which have such a figure, as adapts them to the secretory Pores, and are of such a magnitude as makes them capable of penetrating them that can be admitted: and these are the Particles, of which the humour that is naturally separated by every particular Gland, does consist, whilst others that are differently figurated, and some of those which are capable of entering the glandular Pores, being hindered by more forward Particles, are hurried into the Veins.

The manner of GLANDULAR SECRETION. III

When I make the adaptation of the figure, and magnitude of the parts, which are to be separated to those Pores of the Glandules which secern them, to be the great reason why they have a free passage into them, when some others are necessarily excluded; and why every Gland is so constant in the separation of its proper and natural humour, some may be ready to object that there are Particles of a different figure separated by every Gland: so through the glandular Pores in the Kidnies do pass both aqueous and saline; and thro' those of the Liver, besides salt and aqueous Particles, some which are of a sulphureous nature, and so in others. And since it must be granted that the Particles of all these Principles are of a different figure, we cannot suppose the adaptation of their figure to that of the Pores to be the reason why every Gland does secern such or such a humour, when it is impossible that the figure of more than one should correspond to it; and therefore we must allow something of a ferment to precipitate it, and to give it its peculiar Nature. To this it may be answered that it is not here supposed that the Pores of the Glandules are agreeable in their figure to the Particles of any one pure Principle, whether it be Salt, Sulphur, or any of the rest, since there are none of these to be found sincere; but the Particles separable

able thro' the Pores of any particular Glandules, are, as I have already said of the Constituent parts of a Bone, a composition of two or more of those, which we call Principles; and from their proportion, and the manner of their union in a Particle, does arise the form which accommodates it to the figure of the Pore which it is to penetrate. And do we not find that there is such an agreement, and such an aptitude in some of them which we call Principles (and which perhaps may be yet more simple and fewer than we suppose them) to unite, that all the power of the Fire and the tricks of the Chymists could never separate any one of them, so that they could pretend to exhibit it sincere?

But to come to the nutritious Glandules, which it does more properly concern us to speak of at this time, I have supposed that in their situation they are different from all others that separate any Juice or humour from the Mass of Blood; that whereas others are placed at the extremities of the Vessels, which convey the Blood to them, these are seated on the sides of those Vessels. I did likewise observe that there is something like their situation in the Lacteal Glands of the small Intestines, where all the Pulpe of our digested Food, especially in the *Jejunum*, and the *Ileon* passes from one Glandule to another

other ſucceſſively, and yields the ſame ſort of Liqueur to ſeveral Glandules in the ſame Canale, as it is reaſonable to think that the Blood ſupplies the nutritious Juice to ſeveral glandular Pores in every ſingle twig of an Artery.

Though this ſituation of the nutritious Glandules be different from almoſt all others, yet is it not irregular: for if we conſider how ready they ſtand in this poſition, for receiving thoſe Particles which they are to ſeparate, and for the continuation of their direct motion, I do not ſee if their uſe would have admitted of it, and they had been diſpoſed in the manner and order of the Glandules of the *Viſcera*, that they would have been plac'd more conveniently for the performance of their Office of Secretion, than now they are. Neither is that propoſition I laid down, that the Glandules are ſo ſeated as to favour the tendency of the Particles which they ſecern, and their direct motion, at leaſt more than the Veins, contradicted by the ſituation of theſe. Nay, it is ſo far from this, that it is demonſtrable they are more advantageouſly placed, and ſo ſeated as to give the Particles which they are to entertain, leave to move forward in a more ſtreight line than thoſe which are ſeated at the extremities of the *Vaſa Adferentia*, do: for the motion into
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them is from some part of the arterial Channel, tho' we suppose it to be a single streight twig, more direct than to the extremity of that Artery. This will evidently appear to be so, if we consider how the Arteries, as they proceed, are contracted, and grow less and less: for if a streight line were to be drawn from some part of the arterial Channel, where it is large, to begin at a little distance from any one side of it, and to run that way which the Artery tends, it would, after it was carried a little way, run through the Coats, or that side of the Artery which it is next to; so that whatever moves forward near the side of the Artery, where it is more large, must necessarily, when it advances forward to that part where the Artery is so contracted, that the side of it is drawn into the place where the streight line of that matter's motion runs; there, I say, it must necessarily strike upon, and press against that part of it: so that if it meets there with a free and convenient passage, it does more naturally proceed into that Pore, than pass on farther in the arterial Channel, where it is put somewhat out of its direct Road, and oblig'd to an oblique motion. As suppose in the second figure, Tab. 1. *a, a, a*, to be an Artery gradually contracted, as it proceeds towards *b*, and the Particles of the Blood *c, c*, to be moving in it
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from the contrary extremity; when any of these Particles are advanced in the Artery, as far as *d, d*, the line of their direct motion does not run towards *b*, but on in the lines *e, e*, towards *f*; so that their endeavour will be to proceed in those lines, and they will necessarily make a pressure upon the sides of the Artery at *d, d*. Besides, that the Blood does thus strike against the sides of the Arteries, and that with a force sufficient to carry any Particles of it thro' and beyond the Coats of those Vessels, if there only be passages agreeable to the figure and magnitude of any of them, is evident to our Senses in the Pulse, and the violent eruption of the Blood, when any one of them is pricked.

The Particles therefore which are design'd for nourishment, being carried by the motion impress'd upon them and their natural tendency, whilst they are in motion with the other parts of the Blood, against the sides of the Arteries, pressing upon them, and finding Pores convenient, particularly for their passage and the continuation of their motion in a right line, do proceed into them, leaving the rest of the Mass of Blood to continue its course in the Artery, and out of that into the Venose Channel. And having enter'd the nutritious Glandules, they are pressed forward by every systole of the Artery, as the contraction

or subsidence of it renders the glandular Cavities, placed in the sides of it, more narrow; and perhaps by a power of contraction, which may be in the Glandules themselves: and they are propelled by Particles of the same nature, coming behind them in every Diaſtole of the same Veſſel, till they are driven into the Interſtices of the Fibres of the bony Strings, and every other part where the Spirits move; where it is evident that they will lie in the way of the Spirits motion: and then they come to be more immediately employ'd in the Accretion of young Animals.

From the ſuppoſition of theſe nutritious Glandules, and the manner in which the *ſucus nutritius* is ſupply'd to all the parts, as I have explain'd it, I might give ſome probable account of an *Anaſarca*, and the manner how it is produced; but I muſt conſider I have been already a Tranſgreſſor, and deviated too much from my argument, ſo that I muſt expect ſome other opportunity to ſpeak of that.

For the better underſtanding how the nutritious Particles are managed, when they are ſeparated by theſe Glandules, and thrown into the way of the Spirits motion, I ſhall lay down theſe following propoſitions.

First, That as the Spirits have a direct motion *à termino ad terminum*, ſo have they a circular or rotatory motion turning round
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their own Centers. Neither do I suppose a rotatory as well as a direct motion in the Spirits, merely to serve my present purpose, and without any other reason than that I may accommodate their motion to my Hypothesis; but if we consider the Spirits simply in themselves, and without any respect to the part that they act in our nourishment, we cannot think otherwise than that they do *rotare* in the line of their direct motion; when we find in the projection of a Stone out of our hands, or out of a Sling, that it turns round, as it moves forward. And to instance in some things, to which the nature of the Spirits seems to have a very near access, as Fire and the Rays of the Sun: Do not the *Scintillulæ*, struck off from a Flint, plainly move round their own Centers? Do not some effects of Fire, and the Rays of the Sun discover more than one single or a direct motion in their Particles? For how can we conceive that they should inkindle combustible Bodies that are solid, and melt the most obdurate Metals, disunite their parts, and dissolve their texture, merely by a direct pressure, which without such a violent rotation of the fiery Particles, as distracts and moves the Particles of the Body which is melted or set on fire, some one way, and some another, would propel or elevate the whole *Moles* of the solid Body at the

same time, without disturbing the order, or altering the situation of those parts of it which are fix'd and united. But I think I need not insist upon any argument to prove a two-fold motion in fiery Particles, when the notion, which Philosophers now generally have of the nature of Fire, may save me the trouble of arguing for that which I would here suppose : which being granted, may go very far to persuade us, that there is the same variety of motion in the Spirits.

Secondly, The Spirits will endeavour to remove whatever lies in the way of their motion. What Body soever is mov'd, as it has a natural *conatus* to persist, so it will offer violence to any thing that lies as an obstacle before it, proportionable to the power of its motion, endeavouring either to drive it forward, and to make it comply with its own streight tendency when the impressiion is direct; or to divert and cast it off to one side of that line in which it moves; which is done when the impressiion is more lateral, or the Body moving, acts upon that which is mov'd by a rotatory motion.

Thirdly, The Spirits, by the power of their circulatory Motion or Rotation, will carry the nutritious Particles to one side of that line in which they move, if there either actually are spaces to entertain them, or any can be forcibly obtain'd by the power of that motion which deter-

determines them thither: I say, the Spirits will rather carry them thus laterally, than give them a direct tendency; since the *succus nutritius* is liquid and gelatinous, and the parts of it not so fit to maintain a direct motion, but apt to adhere; that when the Spirits impinge against them, and when the nutritious Particles apply themselves to the Spirits, they will certainly move circularly with that part which they stick to. But the Interstices of the nervous Fibres, and of the Strings of other parts being repleted with Spirits, it is plain that the nutritious parts, when they are by the Spirits rotation carried to any side of those Interstices, between which and the Spirits there is no distance or vacuity, will have some stop, so that they adhere there, and are not able to proceed any farther in that Circle in which they were moving. Suppose a Bowl running upon the ground, and the most forward part, as it is in motion, meets with and strikes upon any matter that is viscous, the matter adhering to it will turn with it, and so that and the part which it sticks to, will be both in their Circulation brought to the ground at the same time; and the Bowl running close to the ground, tho' it has nothing to confine it, and necessarily to keep it down on the other side, does not carry all the matter quite round; but pressing it against the Earth, leaves some

part of it sticking behind, whilst the Bowl it self proceeds. Suppose it were a Body that were not viscous, only it is not so solid as to be reverberated by it; as a piece of Cotton, Wool, Cloath, or any such thing, we find it does not receive so much a direct motion from that of the Bowl, which is so, as a lateral, from its Rotation; so that if any thing of their nature occurs, the Bowl, in turning, will drive it towards the Ground which is to one side of its direct motion. And indeed, when the power of a rotatory motion in one Body, acts upon another that is truly solid, the natural tendency of that which receives the impressi^on, is not directly forward from that part of the Body from which it receiv'd it, but lateral.

Fourthly, Whilst the Animal is young and tender, the tone of the parts is more lax, the Fibres are more tensile; so that in any intermediate part between their extremities they are capable of yielding to a pressure, and receding laterally: and whilst the Particles are not yet united, they are in a capacity of being removed and set at some distance, one from the other, by the insinuation of any new matter between them. And thus the bony parts, whilst they are soft and cartilaginous, are in such a state, that the Particles of one series can be moved laterally from them of another; and those of the same series are capable of receding from one another at their extremities.

Fifthly, The same power of the Spirits Rotation that carries the nutritious matter to the sides of the Fibrils of the Strings of the Bones, or any other part, will by crowding this matter against them, oblige their Particles to recede laterally; and by driving it into the Interstices between the extremities of the Particles, set their extremities at a greater distance from one another.

I shall now see how far and fairly we may be able with these propositions to solve the *Phænomenon* of *Accretion*, and give a particular and summary account of the manner how it is performed. The nutritious Particles therefore being separated from the Mass of Blood by their proper Glandules, and carried into the Interstices of the fibrous Threads, and of the Strings of the Bones, come under the disposal of the Spirits, and the power and influence of their motion. And were there not such an active Principle to give a motion to the Particles of the nutritious Juice, and to dispose of them, to preserve the Interstices into which they flow, free from those obstructions which a matter of such a gelatinous and viscous nature, as renders it incapable of diffusing it self freely, and being otherwise equally distributed to all the parts of a Fibril or bony String, would be apt to create; how soon would they clog and obstruct the Interstices,

stices, and intercept the nourishment which is necessary for the increase of that part which lies beyond the obstruction, and ought to have a supply of the *succus nutritius*, from that Glandule whose secreted Juice did first produce the obstruction? So then the Spirits in their passage meeting with the nutritious Particles lying in the way of their motion, will naturally endeavour to remove them by a pressure, arising from that which is natural to all Bodies that are put into motion, a disposition and a *conatus* to persist in it.

There seem to be two ways which the Spirits have, as they have a twofold motion; to clear their Road, and to prevent the interruption of their flux, and the alteration of their tendency: one is by communicating a direct motion to the Particles which lie in their way, and such a degree of it as shall make them move with an equal velocity; which must be done by that which in themselves has a direct tendency; or else by driving them laterally, by working and winding them to one side of that line in which they move, which is done by their Rotation. But whilst the Fibrils and bony Strings are capable of receding and giving way to the pressure of the nutritious Juice, the Spirits must necessarily act upon it by their Rotation, as it is gelatinous and of an adhering quality; so that they must
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carry it to the sides of the Interstices in which they move, and drive it upon the minute Fibres between which those Interstices are formed. But supposing the Spirits could at this time act upon it by their direct as well as their rotatory motion, this would not necessarily divert or keep off the nutritious Juice from the Fibres, which lie on one side the line of their direct motion: for altho' a Body moving in a streight line will make such an impression upon another that lies in the way of its tendency, as shall transfer a direct motion to it; yet the incidence of one may be such, and it may in such a manner impinge against the other, as to communicate a lateral motion to it by that which in it self is direct.

But then there must be room to lodge this nutritious matter in, that the Rotation of the Spirits may be able to carry and fix it on one side of the line of their direct motion: for if it could not do this, but the nourishing Juice lay always under the power and pressure of their direct motion, it must necessarily be disturbed and driven along in the Interstices in which they move, so that it could never have leave to fix upon their sides, and unite. As for the space therefore, or vacuity, which is requisite to this end, tho' there is no place actually void, before the *succus nutritius* is driv'n upon the fibrous Threads and bony Strings, because

because the Spirits fill the small Channels in which they are moving; yet it is obtained both in the Bones and Fibres, as in all other parts, by that force with which the nutritious Particles are driven upon them: for whilst the Animal is young, the Bones are soft, the fibrous parts are very tender, and the Particles of which they consist, not so entirely and firmly united as they afterwards appear to be. So that the nutritious matter, crowded against them by the Rotation of the Spirits, does extrude them laterally; and taking possession of that room which the pressure of it makes, does adhere to the sides of them, and so makes an addition to their crassitude. And as it thrusts them out laterally, so that part of the nutritious matter which is carried by the same Rotation of the Spirits to the Interstices, which are between the extremities of the Particles of which the parts consist, being driven in like a wedge, it causes them insensibly to recede, and sets the extremity of one Particle at a greater distance from another (yet by such insensible degrees, and in such a manner, that the continuity of the part is still preserved) so that the line which they lie in, will be extended, and every Series of them elongated, where the nutritious matter fixing, being united and becoming a substance of the same nature as the part is of
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which it gives an increase to, adds to the length of it. Thus the Spirits, so long as the Particles of the Bones, and other parts are capable of receding, and will make room to entertain the nutritive parts out of the way of their direct motion, will drive them upon the sides of the bony and fibrous Strings, and by that pressure oblige them to recede, where the *succus nutritius* not only has time and liberty to adhere to them, but by the Spirits Rotation, as they continually pass by, is kept close and contiguous to the parts, until it is more firmly united: and as the nourishing Particles that are once lodged there, are crowded nearer to one another by those which are afterwards supplied, and as it were, knock'd closer together by the rotatory motion of the Spirits, the matter contracts a solidity, and at last assumes the nature of the part which it nourishes.

Thus are performed the separation, the dispensation and disposal, and lastly, the union of the nutritive parts to those of the Body, which they augment: so that I have finish'd that part of this Discourse which concerns Accretion, so long as it proceeds. I shall only observe how reasonable it is to think that the gelatinous nature, the viscosity of the *succus nutritius*, and its coming in the way of the Spirits motion, do retunde the violence and quick-

quickness of it, and consequently temper that heat which the Spirits continually maintain; and that the Hectical heats, which attend Consumptions, and often follow upon great evacuations, are from the want of this gelatinous Matter to lie in their way, to check and balance that violence and velocity with which they move.

But I pass on to the second thing to be consider'd, which is, The reason of the limits of an Animal's growth, and what it is that puts a stop to it, when the Animal is increased to the convenient and ordinary magnitude of the Species. This is either from a defect of the *succus nutritius*, and because the nature of the Ferments which serve for Concoction and Chylification, and the Crasis of the Blood, at that time when Accretion ceases, undergo such an alteration, that the one does not produce, nor the other contain such nutritive parts as are fit to be separated by the nutritious Glandules: or else these Particles are still supplied; but when they are separated and carried into the Interstices of the fibrous and bony Strings, or any other part, they have not leave to fix, and are not united to the part which they are fit to give an increase to. That the first is not the Reason, is evident: for although the Blood and Ferments, like other fermenting Liquors, may undergo some alteration

ration from time: though the Blood may be thought to amit much of its first sweetness and balsamick nature, and to grow sharper or more acrious with age: and tho' we see it is so altered after some certain time, as to contain and supply a Liquor which was not before to be separated or observed, as that which in Men serves for propagation; and we might reasonably suppose that an alteration in the Blood on the other hand renders it incapable of affording such a *succus* as it had yielded before; that as Nature produces one when it is necessary, so she puts an end to the other, when it is not. I say, notwithstanding all this, we cannot suppose such an alteration and such a defect to be the thing which puts a stop to an Animal's growth, I mean naturally, and where the Animal is in a healthful State: for it plainly appears that there is a *succus nutritius* which is fit to be apponed and to give an increase to the parts, after the Animal ceases to grow, in that there is a reparation; and that not only of the fleshy parts, but even of the Bones, when they have lost some part of their substance: as *Diemerbroek* tells us of an adult person, who had a part of the *Tibia* sawed off; that afterwards the Leg was extended to its former length; and after it was Set, was kept quiet and streight in a wooden Cradle, and by a *Callus*; which we cannot suppose

pose to be any other than the *succus nutritius* of the Bones, shooting from the ends of both those pieces where the Fracture was made: the loss of that part which had been taken off, was repair'd, and the broken pieces again united; and the same is more commonly seen in the Skull, when it has been trepan'd.

The reason therefore of this limitation I take to be, because the nutritious Particles, when they are separated by the Glandules, and carried into the Interstices of the fibrous Threads of the bony Strings, and the other parts, are not suffer'd to lodge and unite to the parts which they were wont to nourish; and the reason of their disturbance is, because the Fibres are so tense, their proper parts so contiguous, and the extremities of the bony Particles so firmly united, that they will no longer recede and make room to entertain them, where they may be out of the way of the Spirits direct motion. For altho' the nutritive parts, when they are driven by the Rotation of the Spirits against the Fibres and the Strings of the Bones, can oblige them, so long as they are more lax and tender, and their Particles more weakly and not universally united, to give way, and so thrust themselves into, and fix in a place where they are out of the way of the Spirits direct motion: and altho', so long as the Spirits have a power either to
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force them laterally, or to remove the extremity of one from another, and to make an Interstice between them, they will, by their circular motion, carry the nutritious Particles to one side, and fix them upon the filaments; yet when the Strings or fibrils are so streight, and their particles so entirely united, that they can no longer give way to the pressure made by the Spirits Rotation, or the nutritious Particles, acted by them; so that there is now no possibility of obtaining any place, by which convenience the Spirits may make use, and have the benefit of their rotatory motion, to carry the nutritious Particles to one side of that Line in which they move; the *succus nutritius*, tho' it continues to be afterwards supply'd, cannot have the liberty to lodge and unite, as it did before: for still the Spirits naturally endeavour to remove them, that they may neither stop their motion, nor alter their tendency. And now they begin to act upon, and to agitate them with their direct motion; which, instead of driving them to, and fixing them upon the Fibres and Strings of the solid parts, will carry them along in the small passages or Interstices, in which they move to the extremities of those Interstices to the habit of the Body, and to several Glands; by some of which they are excerned and continually spent. And though the incidence of

one Body, moving in a streight line upon another, may be such as will communicate a lateral motion to it; yet where there is no space for the Body agitated, to move laterally or obliquely into, it will necessarily lie under the pressure of that Body which moves it; which pressure will drive it along in that passage wherein they are both moving. So the Spirits, though they have a rotatory motion; yet as they fill the small Cavities in the fibrous parts, and the Channels through which they move in the Bones, especially when the Blood is in the best condition, and most capable of supplying a Nourishment, they can no longer fasten any of the nutritious Juice upon the sides of the Interstices, in which they flow, or suffer it to lodge quietly, and fix there: then the parts will recede, and allow so much space as will receive the nutritious matter to one side of the line of their direct motion. As supposing a Ball exactly fitted to the Cavity of a Tube, to be moving from one end towards the other, and that it likewise turns round its own Axis; supposing any matter that is viscous lies in the way of its direct motion, so that the one impinges against the other, and the viscous Body adheres to that which is in motion; it is true, the circular motion of the Ball will carry it to the side of the Tube, but it cannot fix it there,

there, so as to leave it behind, and proceed without it ; because no manner of incidence, no Rotation can carry the matter beyond the extension, and from under the power of the direct pressure of the Ball : so that it must necessarily, when it has by its Rotation carried it to the side, drive it on, by its direct motion, to that extremity of the Tube towards which it tends.

The account which I have now given of the limitation of Accretion, may not only satisfy us how there comes to be such a diversity in the size of Animals of a different kind, and the time which they are allow'd to grow in : but when daily observation tells us, that all the Individuals of the same Species are not strictly limited to the same degree of magnitude ; some carry out their dimensions farther than others ; and some cease to grow sooner than some, this Hypothesis will serve to explicate the cause of the difference. And the reason of it is, because the Fibres are sooner tense, and their proper Particles more contiguous to one another, and inseparable to that power which they have to resist ; because the Particles which constitute the bony Strings, are sooner entirely united at their extremities in some, than in others : after which, be it earlier or later, the Spirits come to act upon the nutritious Particles by their

direct motion; upon which the growth of the Animal necessarily ceases: though for the different magnitude of some Individuals, it must be granted, that a more copious supply of the nutritious matter, and a greater plenty, and more vigorous activity of the Spirits to dispose of it; and to make a greater pressure upon the parts, whilst they are capable of giving way, both laterally and at their extremities, are sometimes the cause why some are larger than others. And I do not question, but the Bones may contribute something in their increase to the elongation of the fibrous Threads, as their growth does insensibly stretch the Fibres which are annex'd to them.

As for the defect of Accretion, which is the Symptom of any Distemper in Children, or any persons not adult, it seems commonly to be from the want of a *succus nutritius*, and a deficiency in the quantity and vigour of the Spirits; besides that their appetite is languid, their Diet sparing, and the motion of their Spirits too slow and weak to attenuate the nutritive parts; the Ferments, which serve for Concoction and Chylification, are so depraved, that either they do not extract, or they do not form such Particles as are adapted to the figure of the Pores of the nutritious Glands, according as the use and design of these

these Ferments are either to work upon the nutritious Particles, so as to give them a convenient figure, or only to dispose them, being already conveniently figurated for a separation.

And thus much shall serve for the business of Accretion. That which comes next to be consider'd, is Nutrition: and this I take to be rather a supply of the fluid parts, and a maintenance of a plenitude in all the Pipes and Vessels of the Body; such a continual reparation of Spirits, nutritious Particles, and of all the humours in the Vessels, Nerves and Fibres, as keeps their Interstices and Cavities replenish'd, and the parts themselves in a due temperament: I say, it is rather this, than the apposition of new Matter to the solid parts; tho' I will not deny, but some Particles which were joined to, and become a portion of a Fibre, or any other solid part, may be sometimes rubbed off and separated from the translation, of which there will follow a vacancy, or void space, for entertaining some fresh nutritious Matter: and wherever it happens, so long as there are Spirits, they will, by their Rotation, immediately determine some new Particles to those vacuities, to supply the place of those which are removed. When the fibrous parts are eroded by Ulcers, and the Interstices, in which the Spirits move, and to which the nutritious Particles are supplied, are set open, so

that the Spirits can by their rotatory motion act upon them, and carry them to one side of their direct motion, we find such a supply of nourishment as repairs the loss, and creates a new Flesh. Or, when a Bone is broken, it being impossible so exactly to set it, and to bring the two pieces so close together that there shall be no preternatural Interstices where the Fracture was made, there will be some little spaces found, which will be lateral to those Interstices in which the Spirits move, and the nutritious Juice flows, and convenient for entertaining that part of the *succus nutritius*, which the Arteries, that serve for their Nourishment and the nutritious Glandules supply, and which the Rotation of the Spirits will determine to those vacuities; where being lodged out of the way of the Spirits direct motion, and of that disturbance which their direct pressure must give it, it quietly fixes there, and is united to the part: and this is that which we call a *Callus*. I say, there may be, and is all this; but we cannot reasonably think, that the substance of the solid parts is always in such a flux, as ordinarily to secede and to give way for the succession and apposition of new Nourishment; no not so as to be once universally renewed in the whole interval between the Womb and the Grave; nor that the imminution, which appears in
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the solid parts of an Atrophy, is from the loss of their proper substance, but rather from a subsidence of the Vessels, the driness of the Fibres, or the exinanition of their Interstices, and the emptiness of other Cavous and containing parts; all which, for want of a plentitude to keep them distended, and their Cavities enlarged, are contracted; so that the sides of the Vessels, and the Filaments between which the Interstices are formed, which before by a fulness of volatile and fluid Matter were preserved larger and distended, come nearer to one another, or fall together; and the part whereunto those Vessels and Interstices belong, must lose so much of its breadth and crassitude as proceeded from their fulness and distension.

To make our selves sensible how the fleshy parts are capable of such a subsidence as will detract from their thickness and latitude, even to a *Marasmus*, we need only consider how the whole Body is *vascular*. This the most ingenious Dr. *Tyson* has in some Lectures of his, publickly asserted. And besides the Authority of so curious an Anatomist, those that will be at the pains of making an enquiry, may make a great step towards their satisfaction in this matter, by their own observation. For when any of the *Viscera*, even those which seem most compact and free from Pores

and Cavities, are strictly examin'd, that which was formerly taken to be only a *Parenchyma*, or Mass of congealed Matter, appears to be nothing but Vessels for the Motion and Conveyance, and Vesicles or cavous Glandules for the Separation, with Cavities in some, for the reception of some fluid Matter; which the indefatigable and sagacious *Malpighi* has discover'd, and sufficiently convinc'd us of. And wherever our Senses leave us wholly to the conduct of our Reason, we may rationally think that the structure of the parts is Vascular. For how certain is it that the Arteries are continued, where we cannot discover their Cavities? Who questions, but that the Nerves have their *Canaliculi*? They that maintain the motion of the Spirits, or a *succus nervosus* through them, do implicitly grant it. And if they have their small Pipes whilst they are Nerves, there is no reason to think their *Canaliculi* terminate when their Fibres are expanded in a Muscle, seeing the Fibres themselves are continued. The whole Body therefore being Vascular, we need not suppose any thing more than a subsidence of the Vessels, to explain the immediate cause of that immutation of the fibrous parts which is seen in an Atrophy. The Veins and Arteries not being distended as they ought to be; the nervous and fibrous Channels not being replenish'd; the

the vesiculous parts, such as the Fat is contained in, being empty and contracted, the consequence of all this must necessarily be a remarkable alteration in some dimensions of the part which they constitute.

The nature of the humours and Spirits, it is plain enough, is such, that they may be easily evaporated, or some other way excerned out of the Body. What quantities of them are sometimes lost by Sweats, and other ways of evacuation? And in Ulcers, where the *Fibrillæ* are eroded, and the Pipes in which the Spirits move, and to which the *succus nutritius* is supply'd by the nutritious Glandules, are set open, so that both may extravasate; what an expence of the nutritious parts, and consequently, what a notorious defect may we observe in Nutrition, when the Ulcers are large? so that we have often an Atrophy, not only of that particular part where the Ulcer is, but even of the whole Body. Besides, the nature of the Fat and oily parts, which make a considerable addition to the extension of the parts to which they are supply'd, not only is such that they are capable of being put into a flux, or made fluid; but they are actually liquid, whilst the natural heat of the Body remains; so that they are easily divided from one another, and separable from the parts which they lie contiguous to, and so excernible

nible out of the Body. And unless there be a fresh supply, to repair the loss of that which is evacuated, and did before fill their small bags, these *Vesiculæ* will contract themselves, or subside; which is natural to parts of their Texture and Fabrick, when they are empty; and their subsidence will detract so much from any dimension, as the Matter which before distended them, added to it.

But the substance of the solid parts is such, that it can neither be exhaled, nor melted down by any heat of the Body; so that if they do indeed suffer an imminution in their proper substance, it must be by the way of an erosion; and be the injurious effect of such a corrosive Matter as will dissolve them, and eat off the Particles, the consequence of which would be Ulcers in all those parts which are thus imminish'd: and such a Corrosive could not so affect the Fibres, without the conjunction of an intolerable pain; and the torments of the Stone and Gout would be moderate and easy to them, which in a Consumption would be universal; whereas in a *Tabes* we have no such Symptom. To which may be added another Argument, which seems to prove against all contradiction, that the imminution is not in the solid parts; which is, from what we cannot but observe in the Bones in the greatest Consumptions, that whilst o-
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ther parts are fincking and tabid, they are not found to lose any thing of their magnitude. And why so? Were there a corrosive humour that eats away the very substance of the Flesh, where it is affected with an Atrophy, it would prey as certainly and more voraciously upon the Bones: for upon trial it appears, that a Corrosive, as *Aqua fortis*, will sooner perfectly dissolve a piece of a Bone, than the same quantity or weight of the muscular Fibres. The reason therefore is, because the Strings of the Bones are more rigid; so that, though the Bones may be equal sufferers with the Fibres, that is, their Spirits, and nutritious Juice may be subtracted in a Consumption, as they are in other parts; yet still they keep the same posture that they were in before; and being uncapable of a subsidence, they are not attended with the same symptom of an evident imminution.

The loss therefore of what is expended, being in the Spirituous, the Humorous and Fluid parts, and Nutrition being only the reparation of those parts which Nature continually suffers the expence of, it follows, that it is no such thing ordinarily as the repairing of dilapidations, or the filling up of breaches in the solid or containing parts, but only a supply of such Matter as continues in a Flux, which keeps them full, and maintains the natural circumference of every part.

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There is one thing which I promised to do under this Head ; and it is, to answer that objection which is levelled against the Opinion, that the nutritious Particles are derived from the Mass of Blood ; and is urged as an Argument, to prove they are supply'd from the Nerves ; which is taken from the observation of an Atrophy in some Palsies. The strength of this objection is wholly depending upon a false Notion about Nutrition, to wit, that the substance of the solid parts is in some measure daily expended and lost ; and that the *succus nutritius* is apponed and united to the parts in the whole course of a Man's life, as in the time of Accretion ; otherways it has not the strength, either of an Objection one way, or of an Argument the other : for if Nutrition be only maintaining the fulness of the Vessels which contain the several humours and oily parts, and that of the Cavities, of the Fibres, and an Atrophy, be only a subsidence of all, or some of these ; the subsidence, if it were only of the Nerves and muscular Fibres, shews only a defect of something to fill their Cavities, and does not prove it to be the want particularly of a nutritious Juice, when it may be a deficiency of Spirits only. But we may safely grant the very Notion upon which the Objection is grounded, to be true, that nutrition is, what they would suppose, a Reparation of
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the solid parts, without the least prejudice to that Opinion, that the nutritive parts are supplied from the Mass of Blood, tho' they do not answer the end which they are designed for, in a Palsy. For altho' the Mass of Blood, in which we suppose the nutritive parts reside, continues to Circulate thro' any part that is Paralytick; yet the want of Spirits will have this effect to hinder the separation of the nourishment, when the evil spreads it self so far as to affect the Fibres of the nutritious Glandules; for without the Spirits, the Fibres of these parts lose their tone, and can never be kept tense, nor the natural figure of the glandular Pores be preserved; which being alter'd by the relaxation of the Fibres of the Glandules, become incapable of separating those Particles which are adapted to the natural, but disagreeing from the present figure of their Pores. And by that account which I have given of Nutrition, it will be no difficult thing to explain the reason of an evident abatement in the natural magnitude of any part, when it is the consequence of a Palsy; for the Fibres being obstructed, and the influx of the Spirits, which ought to fill and inflate them, and the supply of their *succus nutritius*, which, as I have already shewn, is naturally supplied, tho' not apponed to the solid parts after Accretion ceases, being hinder'd, there

there will necessarily follow the loss of so much of the magnitude of any parts, as proceeded from that measure of Spirits, and their proper nutritious Juice, which is now denied to them. And besides the subsidence in the nervous Pipes, there is also a contraction or falling of the Blood-Vessels: for the expansion of the Particles of the Blood, and the turgescence of those Vessels, in every part depending much upon the motion and energy of the Spirits flowing into it, it cannot be thought, tho' the Blood continues its influx into any paralytick part, that the sanguiferous Vessels will be so much dilated, when the obstruction and defect of the Spirits are so great, that they cease to flow into, and give an activity to the Blood that circulates thro' them, as when it was rarified and expanded. And this difference we may find, especially in persons that are lean, from Heat and Cold; that when the Hands are very warm, the Vessels are more turgid, and the parts are plumper and more large; but when the cold weakens the activity of the volatile Particles, and resists the expansion of those which are agitated by them, the parts seem as if they had some degree of a sudden Atrophy, and the Skin becomes flaccid.

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What I have said of Accretion in general, might be sufficient to explain the manner how the Bones do increase, and how a *Cal-lus* is supplied to a broken Bone ; but because I enter'd upon the consideration of Accretion upon the account of these parts, I cannot but say something particularly of the manner of their increase. That they have many Arteries bestowed, even upon their most solid part, and designed for their Nourishment, I have already observ'd, and given some description of them. By these Vessels is conveyed into them the Mass of Blood ; from which the Particles, that nourish them, are separated by Glandules, seated in the sides of the arterial Channels ; which being carried into the Interstices of the Strings of the Bones in which their Spirits move, will lie in the way of the Spirits motion ; and thereupon are in the manner, which I have already explain'd, by their Rotation or circular motion carried to the sides of the Strings, so as to make a pressure upon their Particles. By this pressure, made upon the sides of them, so long as the extremities of the bony Particles are not united, they force them to recede laterally ; and insinuating themselves between their extremities, enlarge the distance between them, and oblige them to give way : and so they obtain a space, which entertains them
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out of the way of the Spirits direct motion, and where they are contiguous to the bony Particles, to which they adhere and unite.

Neither are we at a loss for Spirits in the Bones, to act their part in this business, since they receive a continual and plentiful supply of them from the *Periosteum*; by the Fibres of which they flow into the Interstices of their Strings, and move in them as their Channels, as they did in those of the Fibres in the Nerves, and all the fibrous parts.

That we may the better understand how the Particles of the Bones are capable of receding both laterally and at their extremities, we must consider that the Bones of a *Fœtus* are soft, and their parts at one time easily divisible; so that they will sensibly yield to the pressure of the Finger. When an Infant is born, they have very much of a cartilaginous Nature, and it is a considerable time before they arrive at the perfect solidity of a Bone. Now a Cartilage, as I shall further shew when I come to discourse of those parts, is nothing but an imperfect Bone; or a Bone, in which the extremities of the Particles are not united to form continued Threads; but there are small Interstices between them, though they are so disposed as to preserve the continuity of the whole Cartilage: and although, when it advances nearer to the true and perfect

fect Nature of a Bone, many of them are united; yet they are not all so, until the Bone obtains its due solidity: so that whilst the Bones are cartilaginous, or bordering upon the nature of a Cartilage, their Particles are capable of receding both to one side, and at their extremities; which, being moved by the pressure of the nutritious Juice, driven against them by the Rotation of the Spirits, they make room for lodging of the Nourishment out of the way of the Spirits direct motion. Those Particles which are driven against, and apposed to the sides of the several parts of the bony Strings, increase the thickness, and enlarge the circumference of a Bone: those which are forc'd in between their extremities, widen the Interstices; and sticking there, elongate every series of the bony Particles, and consequently the whole Bone.

But when these Particles come to be united at their extremities, that will be the boundary of their recedure, and limit the growth of a Bone: tho' I suppose likewise a lateral union, yet the first only will necessarily prevent the farther increase of their crassitude, as well as of their length, where the Strings are continued in the manner of a Ring, as they are in all the Bones. For unless the Spirits have a power of breaking this continuity, they can neither protrude nor elongate these Strings ei-

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ther on one side or the other, after their Particles are firmly united. And as they cannot protrude the parts of a String, so neither can they fix any part of the nutritious Juice upon them, because so long as it is in the Interstices, it must be disturbed and propelled by their direct motion; which may probably drive it on till it comes into some way which leads it to an evacuation. I do think too, that the *Periosteum*, which I have already discoursed of, does, as I then supposed, help to prescribe limits to the increase of these solid parts, when its growth and extension cease. But suppose that none of the bony Strings were so united as to become annular; I mean to be continued in the manner, tho' not in the figure of a Ring, nor any opposition made to their recedure by the *Periosteum*; yet the Bones, and the parts which they consist of, being of a fix'd and quiet nature, contrary to that of the Spirits and all active Particles, so long indeed as the pressure of the *succus nutritius* from the Rotatory motion of the Spirits is so strong and violent as to exceed and overpower the quietude and fixity in those parts, it will oblige them to recede; but when they come to an *æquilibrium*, that the degree of quiescence in these solid parts answers exactly to the power of the Spirits motion, much more if it exceeds it, the fixed Particles of the Bones will
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begin to stand their ground: and none can without absurdity suppose they should be moved and protruded by that force which they are able to resist.

What I have said of Nutrition in general, I may confidently affirm of that of the Bones, that it is not ordinarily a reparation of their substance or solid part, or the succession of new Particles to any that are destroy'd and expended after they are assimilated: for the Particles of these solid parts are so fixed and firmly united after the time of their Accretion, that their Nature will not give us leave to think they are capable of such a flux as is necessary to such a change and succession of Matter; so that their Nutrition is no more than a constant supply of Blood to their sanguiferous Vessels of Spirits, to the Interstices of their Strings, and of their nutritious Juice; which when a Bone is broken, or deprived of part of any of its *Laminæ*, though it be after the time of Accretion, is upon these occasions employ'd and appon'd in the same manner as it was when it gave an increase to these parts; it is carried by the Rotation of the Spirits to those Interstices and defective parts, where a *Callus* or bony substance is necessary to knit the pieces which are fractur'd, or to supply what is lost by Trapaning or Exfoliation.

From that Hypothesis, by which I have endeavour'd to explain the manner of the Bones Accretion, we may, as I humbly conceive, be able, rationally to account for the Symptoms which we observe in these parts in the Rickets, and for the *Gummata*, which often appear in the *French Disease*.

The Symptoms which attend some of the Bones in the Rickets, are an Incurvation, a knottiness and protuberance at their ends. The ingenious Dr. *Mayo* has endeavour'd to give us the reasons of the obliquity of some of the Bones in this Distemper, by supposing a disproportionate growth in the Bones, and the Muscles which are affix'd to them; that the nervous and muscular parts, for want of a sufficient quantity of a *succus nervosus*, which he conceives to be necessary to their Accretion, have not that addition made to their dimensions in this case, which they ought to have; whereby they fall short of that length which should give them a proportion to the rest of the parts, and which a natural Accretion would have procured: but all this while he would have the Bones to be nourished, and to increase no less in Rickety, than in Healthful and thriving Children. But as it does not appear that there is any such reason for this affection of the Bones, so if we should suppose the inequality which is in the distribution

bution of the nourishment in this case, to be between the Bones and the Muscles, and not between several parts of the same Bone; yet it would do us but little service in explaining the reason of the Bones obliquity; neither would their Incurvation follow upon what he supposes. The ingenious Author's Notion is this, that the Muscles, as I have said, from a defect of a nervous Juice, necessary to their Nutrition, are not nourish'd and extended as they ought to be; but the Bones, from whence they have their origination, and which their Tendons are inserted into, enlarge their dimensions. Now the origination and termination of the Muscles hindering those bony parts which lie within these bounds, from extending their length in a right Line, that growth and addition which make them exceed the length of their Muscles, will alter their figure, and incline them to that of a Bow: as it is certain, if any Line be elongated, whilst the extremities are fixed within the same bounds, it will necessarily of a straight Line become oblique. This indeed might solve the *Phænomenon*, if the origination of a Muscle were from, and the insertion of it, into the same Bone. But this is evident, that as the Muscles are designed for Motion, so between their beginning and the insertion of their Tendon, Nature has, to

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make the part moveable, formed an Articulation; so that the brevity and streightness of the Muscles would bend the Joint, and not produce an obliquity in the two Bones which are articulated, or in any of them. So long as there is an Articulation between those two extreme parts, which he would suppose to be fixed by the beginning and Tendon of a Muscle; and that part where the insertion is, being not only capable, but apt to be attracted towards the other: where the origination is upon the preternatural shortness of the Muscles, just as it is in muscular motion: where there is a contraction of the muscular Fibres, and their length is not equal to the distance which is between their beginning and insertion, when the Bone, which they move, is extended; there will follow an alteration in their posture, but no one of them will be obliged to alter its figure. Are not the Muscles, when they move any part, so shortned as to put a stress upon the Bones, and to bring that part of a Bone, which they are inserted into, towards their origination? and what do we find is the effect of this abbreviation; have we an obliquity following in the Bones themselves? No such thing; but only a flexure at the Joint. The example he gives us of a young and thrifty Tree, that has, whilst it is growing, the end of a Chord fixed to it, the one
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in the superior part, and the other below, so that the String is extended to its full length; but the Tree at first not at all inclined, is not Parallel. There is no doubt of this; and it is demonstrable, that the Tree, which receives its Nourishment, and is extended in its length, when it cannot carry either of those extreme parts, to which the Chord, that is not equally elongated, is fixed, beyond those limits which were set, before it had this increase: that is, it is incapable of an elongation in a direct Line; whatever is added to the length of it, must be out of a straight Line, and give the Tree the obliquity and figure of a Bow. But we must consider that this is one Stick, one continued Body, which has no Articulation; which if we supposed it to have, the flexure would be only at that Joint, and so all the other parts between the Ligatures would preserve their rectitude and first figure.

Dr. *Glisson's* Hypothesis, methinks, seems to be more rational; that the inequality and disproportion of Nourishment lies between several parts of the Bone, which is thus affected: that the nutritious Particles are plentifully supplied on one side, whilst on the opposite side the Bone wants its due Nourishment; the necessary consequence of which will be an Incurvation, and the Bone will be

reduced to the figure of a Bow, whose Convex will be on that part which is duly nourished, and the Concave on that side where the nutritious Juice is not proportionably apportioned. This he proves will be the effect of an unequal Nourishment in the Bone it self; by an instance he gives. ‘Let there be a Pillar, says he, raised with three Stones, lying one upon another: let us suppose it to be such as is perpendicularly streight on every side, and of the same height; if therefore we put in a Wedge on the right side between the uppermost and the middle Stones, the highest Stone will be inclined towards the left hand, and the Pillar will be raised higher on that side where the Wedge is driven in, than it is on the opposite part: likewise if we drive in a Wedge between the middle Stone and that which is the Basis, on the same side, the pillar will yet be more inclin’d, and stand bending towards the left hand: and the more Stones it consists of, if a Wedge be put in between every two of them, on the same side, so much the greater will the obliquity be in the whole; so that the Stones will no longer make an erect Pillar, but represent part of an Arch; as he has express’d it by a Figure. It is true, every Stone that is thus raised, will with that which it immediately rests upon, make an Angle

gle on that part towards which it inclines; whereas there are no such Angles in these incurvated Bones. But the reason of the difference will appear, if we consider what he farther says: That the Nutrition, which on one side is most considerable, is there in a manner equally performed in all the length of it; and from this equal Nutrition the Incurvation of the Bone will make exactly a part of a Circle, without any Angles.

We will see how this notion may be farther explained by that account which I have given of the manner of the Bones Accretion. Much of the difference between a Bone and a Cartilage, I then observed, to consist in this, that in one, to wit, the Bone, the Particles are at their extremities, which lie opposite to one another in every series, united in the whole length of it, so as to form continued Strings; whereas in the other the Particles are so far from this, that there are minute Interstices between their extremities. Whilst therefore the Bones border upon the Nature and Constitution of a Cartilage, as they do in young Children, the extremities of their Particles are capable of being removed and set at a greater distance from one another, and will admit between them the nutritious Particles like so many Wedges driven in between the Stones of a Pillar: and where the supply
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of the nutritious Juice is most plentiful, and the quantity of the Spirits, which forces the nourishing Particles into them, is greatest, and their pressure strongest, there the Particles of the Bone will be obliged to recede farthest: the consequence of which will be a more considerable elongation of every series on that side; when on the other, if there be any defect of the nutritious Juice, and the activity of the Spirits be more languid, the extremities of the bony Particles will not recede to the same degree, nor the Accretion of that part proceed with an equal pace. And thus one side comes to be shorter than the other; and that part which is most extended in its length, will incline the Bone towards the contrary side, and reduce it to a figure of a Bow.

But altho' this account does fairly explain the reason of the Incurvation of the Bones in the Rickets; yet I do not think that the disproportionate quantity of the Nourishment which is supplied, and the unequal influence of the Spirits are the true causes, why one part of a Bone is nourish'd more than another; but I take it to be rather from some difference in the nature of several parts of a Bone: in one it puts off the form and temper of a Cartilage, more and sooner than it does in others; and if the Particles happen to be united and to form continued Strings, that they are not
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so capable of receding and ready to make room for the entertaining of the nutritious Particles, out of the way of the Spirits direct motion, sooner on one side than on the other; that is, the part is there more hasty in its tendency towards the perfect nature and solidity of a Bone, so that the Spirits and nutritious Juice, tho' their quantity and pressure be equal on every side, cannot oblige the Particles equally to recede; then will the Accretion of the Bone cease on one side, or proceed slowly, if some of the Particles remain disunited at their extremities, whilst it is carried on more effectually and evidently on the other: which may be more fully explained and understood by what I have said of the reason, why Accretion ceases in grown Animals. I must confess, I never had an opportunity to examine the Bones of any rickety Children: however, I am strongly perswaded, if any inquiry be made into them which are incurvated, the Concave part will be found to be more solid, and like the perfect Bone of an adult person; and the nature of the Convex, more agreeable to the age of the Child to whom it did belong. And this we may conclude from the nature of those Oils which we make use of externally to the part affected in this distemper, which are emollient and relaxing; such as are apt to loosen the extremities

mities of the Particles, to dissolve that union, that continuity of them, which makes the Strings more firm and rigid; at least to weaken it so, that the power of the Spirits, and the pressure of the nutritious Juice, acted by them, may be able to dissolve it, and make the Particles capable of receding at their extremities, which is necessary in the elongation of a Bone. And so the reason is obvious, why these external remedies are to be applied to the Concave part of the Bone, when it is incurvated; which is, where the extremities of the Particles are united, and not disposed to recede, and to receive any part of the nutritious Juice out of the way of the Spirits direct motion; which every good Woman, that pretends to cure the Rickets, observes to do.

From this supposition, that the Interstices between the extremities of the bony particles, and the liberty they have to recede upon the pressure of the *succus nutritius*, are that which makes the Bones capable of an increase, we may account for the preternatural increase and knottiness of the ends of some Bones: for in Children, at first, the extremities of the articulated Bones are but tender Cartilages, and some of them, as those of the Wrist, wholly Cartilaginous; and not only so, but that medullary Oil and mucilage which are supplied to, which lubricate and
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moisten those parts that are found to be thus nodous, keep their Particles lax, and prevent their natural tendency to a union: as we see this mixture even in grown persons has so far the same effect upon these parts, that they never obtain so great a solidity, as is in those parts of the articulated Bones which are never moisten'd with the mucilage. In young Children therefore, where these parts of the Bones are naturally soft, and the extremities of the Particles are kept more lax and longer dis-united by a moist and mucilaginous Matter, than the other parts of them, there is sometimes, as in these rickety cases, a preternatural laxness, and a greater indisposition in the Particles to unite, and consequently a weaker opposition to the pressure of the nutritious Juice; whereupon they are protruded in an extraordinary manner, and give way for the entertainment of a greater quantity of the *succus nutritius* than what is necessary for their regular and natural increase.

For the *Gummata*, or Nodes, which appear upon the Bones in the *Lues Venerea*, since by a long continuance, and their induration, they take upon them the nature of a bony substance, it is not to be doubted but that they are produced from the *succus nutritius* of the Bones, as their material cause, which is extravasated and cast out upon their superficies;

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perficies; where it adheres, and produces a preternatural excrescence. The nutritious Juice, after it is separated from the Mass of Blood, comes to flow in the Interstices of the bony Strings: so long as these Channels are entire, and have no breach in all their course, the nutritious Particles are, as it were, kept within their Banks; but when the continuity of the Strings is broken by the least preternatural foramen, then the nutritious Juice finds a passage to flow out at: and when any parts of it come to be opposite to it, the Rotation of the Spirits will carry them into it, and by the succession and pressure of one Particle upon another, they are driven out of the Bone; where lying out from the Line of the Spirits direct motion, their viscous nature disposes them to adhere, and they generate a substance like that of the part which they are fit to nourish. So we find, when the Fibres lose their continuity, and the small Channels in which the Spirits move, and where their nutritious Juice flows, have any preternatural avenues; whether it be by the Knife, as in Issues, that are cut; or by the Corrosion of some sharp and ulcerous Matter, that the nutritious parts contain'd in them, are thrown into those *foramina* and Cavities, to repair the loss of what is destroyed, and to restore the natural continuity of the Strings which are corroded:
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and even where the case is so ill that there is no disposition to heal; yet often we are sensible of the extravasation of the *succus nutritius* from the fungous Flesh that arises. Now the venenose Particles which affect the Blood in the *French* Disease, are both subtle and acrious; which, when they are scatter'd through the whole sanguineous Mass, will be apt to attend any humour that is separated from it, being by reason of their subtility capable of entering the Glandules of any part. For although the Pores of diverse Glandules are differently figured, yet this will not necessitate these Particles to be separated by those of one sort, because they are so minute and subtle as to penetrate those Pores which are of a different figure. And thus subtle we find the malignant Particles in the *Lues Venerea* to be, when they are discharged by several Glands: sometimes they insinuate themselves into the Salivatory, the Urinary, the Pulmonary, the nutritious Glandules of the Fibrous parts, and raise several Symptoms where they are separated and deposited. And as the nervous Threads are sometimes corroded, and the nutritious Juice, extravasated out of their Interstices, produces Caruncles in the fibrous parts; so the same morbidick Particles, when they penetrate the Pores of the nutritious Glandules in the Bones, are mingled and confounded

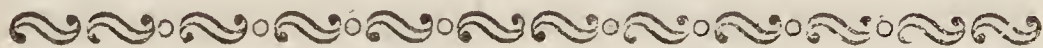
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founded with the Nourishment in the Interstices; where by the means of their subtilty being arrived, by their acrimony they corrode some of the Strings, so as to eat small passages in the sides of their Interstices; which when they reach the superficies, are a way for the efflux of the nourishing parts; which by the power of the Spirits rotatory motion are carried into them, and by the pressure of such as succeed them, are driven to the superficies; where they concrete and produce an excrescence, which represents the nature of the part which they are proper for the Nourishment of.





THE THIRD
DISCOURSE,
 OF THE
MARROW.



THE Cavities, which Nature has formed within the Bones, are neither empty and useless vacancies, nor filled with Lumber and contemptible matter, but convenient Repositories for a curious and refined substance, necessary for the service of those parts that contain it, which is called the Marrow. The nature of the Matter which is here separated and deposited, and immediately serviceable to the Bones, is wholly oleaginous. However, the whole Mass or Bo-
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dy of the *Medulla* consists of several parts, to wit, of Blood-Vessels, both Veins and Arteries, of Glandules, and containing parts, and the oily Matter which is contained in them.

It has Blood-Vessels, proper to it self. The Artery is sometimes single; sometimes there are two or three, and in some Bones, as particularly in some of the Ribs, they exceed that number, having every one of them a distinct *Foramen* formed in the side of the Bone for their passage into the Cavities. It passes thro' these *Foramina* without any division or ramification: for I could never observe that any of them sent forth any Twigs into the substance of the Bone for its Nourishment, but were designed solely for the Marrow. After it comes into the large Cavity, or into the lesser Caverns, when the Bones are spongy, it is commonly divided into two; one ascending towards one extremity, and the other descending towards the other; both of which, in their whole tendency, are so ramified as to give a Twig to every Vesicle that performs the office of a Glandule. Though I have with a Glass discerned several minute Blood-Vessels belonging to a single Bag; yet I cannot say I have been able to observe that every Vesicle has a Blood-Vessel; neither do I think it has: for there being a communication between the Vesicles by Pores, as I shall afterwards

wards shew, there may be a supply of the medullary Oil; to fill those which have not Blood-Vessels of their own in order to supply such oily parts, and do not separate them themselves.

As for the Veins, they run from the termination of the Arteries, some all along within the Marrow to the *Foramen*, thro' which the Artery enters, and fall into one large Channel, which passes thro' the same *Foramen*; others tend to the superficies of the Marrow, whereof some, which are minute, I have observ'd to pass immediately thro' the Membrane, and to penetrate into the side of the Bone; which we must suppose to discharge themselves either into some Vein of the *Periosteum*, if they proceed so far, or into some of them which are in the substance of the Bone, and belong to the nutritious Arteries; others run upon the superficies of the Marrow, between that and the Membrane, which fall at last into that larger Vessel which passes out by the *Foramen* of the Artery. Where there are two or more conspicuous passages, it is probable that sometimes the Vein may pass singly thro' one, and the Artery thro' the other; though I have not yet observ'd it to be so.

The Secretory Organs are small vesiculous Glandules, which I take to be likewise containing parts, and continually kept full by the Oil which they themselves separate; which,

before I give an account of, I shall take notice of a common containing part, investing the whole *Medulla*. The oily therefore, the vesiculous and vascular parts of the Marrow, are all contained in one common, most thin and tender Membrane, transparent as Glass, which invests that part which lies in the bony cells, as well as that which fills the larger Cavities. The origin of this Membrane is certainly from the Blood-Vessels: for here we have nothing else; no other Membrane, no Nerves, no tendinous or muscular Fibres, from whence we can suppose it to be deriv'd. Neither do I think it is from all the Blood-Vessels, but only from the Arteries; nor from all the Coats of an Artery, but from the exterior only: that it is an expansion and an elongation of the Fibres of this Coat. It is so thin, that it does not seem to be made of the Fibres of more; neither have I been able to observe that it is divisible like the several Coats of an Artery, or that it has the least resemblance to any other than that I mention'd, but it is plainly a *Reticulum* or fine Net, like the Texture of that. It seems in many places to be red, as if it had a great number of Blood-Vessels; but this is not occasion'd by Vessels, or Blood of its own, but some of the medullary Veins running upon the superficies of the Marrow which lies under it, by reason
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of its transparency make it seem to retain that colour, which it only transmits. I do confess, I have not been always able, when I have endeavour'd it, to separate the Membrane from the Vessels which communicated that colour to it: for especially where the Marrow is soft, they will rise with the Membrane, when it is separated from the *Medulla*; and it is no wonder when it is propagated from some of the Blood-Vessels, so that there is a connexion; and the implication of these with others, will make them rise together: and it is so tender, that it is almost impossible to divide them afterwards. But I have so often separated them in that part of the Marrow which has been more indurated, and afterwards viewed the Vessels upon the superficies of the Marrow, as to be certain that they are not a part of the Membrane, but only subjacent, and so give it their own colour; as any Opake Body will do to that which is diaphanous, when it lies behind it.

This Membrane adheres to the Bone, not only by those small Veins which are continued from one into the other, but likewise by insinuating it self into the transverse Pores of the first internal *Lamell*, and that, as I suppose, for the better passage of the medullary Oil through one into the other. This is certain that it has Pores, by which the Oil

flows thro' it into the Bone it self, which it is reasonable to think are formed in those parts of the Membrane which lie into the Pores of the first Plate, by which one does more conveniently and certainly receive it from the other. Neither can it seem strange that the Oil should have its egress, after it is separated by the Glands, through Pores formed in this Membrane, when we consider that is not an unparalleled case, but the Sweat, after it is separated by the cutaneous Glands, passes through the *Cuticula* by such Pores. By the elevation or protrusion of this Membrane in several places, to insinuate it self some little way into the transverse Pores, on the inside of the Bone are formed little round protuberances, which render the surface of the Marrow unequal.

The medullary Oil which is contained in this Membrane, does not lie all confused and indistinguish'd in that space which the common Membrane circumscribes: but there are Divisions, and Subdivisions. In the Membrane are immediately contained membranaceous Bags, and in these Bags are *Vesiculæ*, or little Bladders: both which I have observ'd where the Marrow has been soft, and the Oil continued liquid after it was cold. And when I came to enquire into that part of the *Medulla* which was indurated, I found
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by examining of it, when it was made hot and liquid, that the structure of the containing parts was exactly the same; only I could not distinguish the tender Bags so well.

The Bags, or Lobules, made up of several *Vesiculæ*, are not all of the same Figure, nor of the same capacity, even in a large Mass of Marrow; and for those which fill the small Cavities, it is plain, they are variously figured, and different in their extension, as the Cavities themselves are so; and in some of the simple Caverns, which are very small, that which fills them, hardly deserves the name of a Bag; for in some there cannot be more than two or three *Vesiculæ*, and in some I cannot tell how to think there is more than a single Vesicle.

The *Vesiculæ* are small, glandular Bladders, designed for the separation of the medullary Oil from the Mass of Blood, and for the reception of it. These are, as far as I can observe, all of the same figure, being round; neither do they differ in their capacity. In that part of the Marrow where the Oil is fluid and clear, they are, to look to, very much like the vesiculous substance of the Lungs, when they are blown up, but that the *Vesiculæ* are not so large. In a small piece of the *Medulla*, where the Oil is indurated, they represent, when they are viewed with a mag-

nifying Glass, a cluster of small Pearl, sticking one to another. In a human Bone, which I had preserved till the Oil was wholly evaporated, I found these *Vesiculæ* remaining dry, but entire, and their substance representing in a manner a Sponge. The medullary Oil being contained in several small Vesicles, from hence it comes to pass, that if any one of the Bags be open'd, it does not presently empty it self; the medullary Oil does not all gush out together, but Stills forth in such small quantities, that it is some time before it flows all out: nay if the Bag be gently press'd, so as not to break the *Vesiculæ*, it empties it self but gradually, and that because after the Membrane of the larger Bag is broken, the medullary Oil is still contained within the *Vesiculæ*; out of which, whilst they are entire, but such a quantity of it flows forth at a time, as their Pores will permit to pass through them.

They seem to have Pores, or immediate passages out of one into another (and so do the Bags) by which the Oil has a free course to the Joints and substance of the Bone, for whose benefit it was designed, even from the middle part of that Mass which fills the large Cavities, and lies at some distance from the side of the Bone, as well as from the lesser Cells; and therefore in melting of a large
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piece of the hardest Marrow over the Fire, the Oil will by degrees all drop away, and leave the Bags and *Vesiculæ* empty; which shews some passages from the internal part to the superficies. And if we consider the distance of the Bags and *Vesiculæ* in the Centre of the Marrow in the large Bones, as suppose in that of the Thigh, from the substance of the Bone and the Articulations which it is to be supplied to, we must conclude that there is some contrivance for the conveyance of it to those parts; otherwise all the medullary Oil, besides that which is contained in those *Vesiculæ* which lie next the common Membrane, would be of no use to those parts for whose benefit it is intended. It being certain therefore that there is a motion and passage of the Oil in the *Medulla* from one part to another, this must be either by proper Ducts, designed for this end, or else by Pores, formed in the Vesicles, by which the Oil flows immediately out of one into another; and so successively, till it arrives either at the Joint, or the substance of the Bone. By the strictest enquiries I have made, I could never discover any thing like Ducts; neither have I indeed been able to observe the Pores, by which I make the medullary Oil to have its passage; so that thus far one may seem as probable as the other. But I say, No: for if
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there were any Ducts leading from the several Glandules, we should have them, as in other Glands, meet in larger Channels, which would be visible; but the Pores are every where very small, and there is no reason they should be larger in one place than in another, so as to offer themselves to our sight. Besides, let us consider that the Oil is not carried from the Vesicles or Glandules to one large Receptacle, which would require the convenience of Ducts to convey it thither; but flows out of the superficies of the Marrow in as many places as there are transverse Pores in the internal *Lamell*: so that we must suppose these Ducts not only to be almost innumerable in their first rise from the Glandules, but even in their termination, which it is hard to conceive, as it is unnecessary, and is not agreeable to the wise methods of Providence; when there may be a more easy and simple way for the conveyance of the medullary Oil, as the Vesicles in every Bag, and the Bags in the common Membrane do lie contiguous to one another, which affords the convenience of forming such immediate passages out of one into another, as I have supposed.

The Bags and glandular Vesicles are without doubt propagated from the Blood-Vessels, since, as I said of the common Membrane, there are no other parts within the Cavities
from

from whence they can be derived; and they seem to be not only particularly from the Arteries, but from their exterior Coat. Their membranous substance is in the same manner like the common Membrane, transparent, and their texture seems to be every way the same: so that I conceive that the exterior Coat of the Artery expanded and conveniently modified, makes the Vesicles; and being afterwards farther expanded, it produces the Bags; and from the expansion of it beyond all these, arises the Membrane, which includes the whole.

Besides the pressure of the medullary Oil, which is continually supply'd upon that which was before separated and deposited in the Vesicles, to drive it on towards the substance of the Bones, and towards the Joints in some of them, we have some reason to think, that when the *Vesiculæ* and the larger Bags are filled to a convenient distention, they contract themselves, as the Fibres of the Bladder, and such membranous Cavities evidently do upon the same occasion; whereby being like a Sponge compressed, the Oil is squeezed and forced out of one Vesicle, and out of one Bag into another successively; whereby that part which is contained in the Vesicles that lie next the Membrane, is driven through it, and into the transverse Pores of the first internal Plate; and that, which was more remote,
is

is carried on towards it, and supplies the place of what is removed. And how it is dispensed after it comes into the substance of the Bone, I have already shewn, when I gave an account of two sorts of Pores, formed in, and between the Plates.

But I have one thing here to give an account of, and that is the passage of the medullary Oil to the Joints. The manner in which it passes, whilst it is within the Bags and Vesicles, I have explained; but what contrivance there is for its exit out of the Bone, and its flowing into the Interstices of the Joints, I am now to consider, as it is evident that it has a passage into them. For if any Joint be preserved entire, till all the mucilage is wasted, there is to be found, even in the Fingers, where I have not been yet able to discover any large passages, for a long time after, an Oil, transfused and sticking to the ends of the Bones, which is supplied from their Cavities after a Man is dead; where even Death it self leaves a stock to maintain the current of it into the Joints: whereas the separation and supply of the Mucilage ceases as soon as the Circulation of the Blood is stopped: and that which is left in the Joint, is quickly evaporated, or some other way disappears. For this end there are Pores or passages formed both at the extremity of the Bone,

Bone, and in the Sinuses of it, which are on one side. Those, which are at the very end which seems cartilaginous, are very small, but numerous, which in most Bones it is very difficult to discover; but I have a Bone of a Horse, where they are very plain. And here I take the passage of the medullary Oil to be in the same manner as where the Plates lie contiguous in the sides of the Bone, by transverse, and longitudinal Pores. Some of the passages in some Sinuses are very conspicuous, particularly in the Cavity on the hinder part of the *Os Femoris*: at the Ham there is one, which I opened, and traced for some way up into the cavernous part of the Bone; and in the large Cavity on the hinder part of the *Trochlea* of the Shoulder-bone there are in most Skeletons several, sometimes six or seven; one whereof is larger than all the rest; and I did particularly examine one, that was considerable, first with a Bristle, whereby I found there was a clear passage down a great way into the Bone; which when I opened, appeared to be a bony Duct, that ran for some way into the cavernous part, which besides what it had at its termination, had on every side several Pores, by which it opened into so many of the Caverns. And in the same Cavity in the *Os Humeri* of a Horse I have found eight or nine of these passages pretty large,
with

with several others, which were visible to the naked Eye. Now by these Pores the medullary Oil, separated in the Cavities, flows into the Duct, and by that into the Interstice of the Joint. The passage of this Duct, where it opens into the Joint, is in some Animals very large: in a Calf, where it was single, I observ'd it to be larger than that thro' which the medullary Vessels passed into the Cavity: and in fatted Beasts, so without doubt in some Men who are very Corpulent, there lies often over it something like a Fat Gland, fix'd, as it were, by a Root into this passage, which at first I was apt to think was indeed such a Gland, till I came to make a stricter enquiry, and found from whence that Fat was supplied. For as the adipose Glands between the Muscles, so the Vesicles of the Marrow, may often supply a greater quantity of Oil than is expended; and where the Animal is fatted, and little exercised in motion (as those which are design'd for slaughter are excused from Labour) there is more supplied, and less made use of than in some others; so that it is not strange to find some of it sticking upon the Bone, and a superfluity of it even in the Joynt.

I shall not here stay to give any account of the nature of that matter which is contained in the Bags and Vesicles, which I have described,

scribed, when every one knows it to be an Oil: nor is it necessary I should say any thing concerning the manner how it is separated; since what I have said of glandular Secretion in general, is sufficient to explain it.

There is one thing or two, which I shall take notice of, before I proceed to speak of the uses of the medullary Oil; the first is the difference there is between the colour of that part of the Marrow which is in the large Cavities, and that which is in the bony Cells, especially in some Animals; the one being, where it is indurated, of a whitish colour, mixed with a red; the other plainly red. This diversity in their colour proceeds from a difference in the number of their Blood-Vessels: for in that part of the Marrow which is lodged in the large Cavities, I do suppose that every Vesicle has not an Artery to convey the Blood, which supplies the oily Particles to it, nor a Vein to carry it back; but there are some, which by Pores have that Oil that fills them, supplied from other Vesicles, that serve for the separation of it; but those Vesicles, which are in the smaller Cells, have every one of them their Blood-Vessels for this end, which makes them proportionably more numerous, and that part consequently more red. The second thing is the different consistence of several parts of the Marrow, when
they

they are cold. In the large Cavities of some Bones we shall have some, which, after it is cold, is indurated, and of the nature of a Sewet, some of it remaining liquid, even in the same Cavity. Now Oil in its proper and natural consistence is liquid, as well when it is cold, as hot: so that that part of the medullary Oil which remains so, shews it self to be more pure and unmixed; the other, which is congealed, has the addition of something to it, which alters its consistence; and what parts these are, we can learn from nothing better than an experiment, in which such a change is effected in common Oil: and this I have borrowed from the most ingenious Dr. Grew, who in his Discourse of the power of Mixture tells us, how the Fat of an Animal Body may be imitated: *Which, says he, may be made thus, Take Oil of Olive, and pour it upon high Spirit of Nitre, then digest them for some days. By degrees the Oil becomes of the colour of Marrow, and at last is congealed or hardned into a white Fat, or Butter, which dissolveth only by the Fire, as that of Animals. In converting Oil thus into Fat, it is to be noted, that it hardens most upon the exhalation of some of the more Sulphureous parts of the Spirit of Nitre. ---- Hence the true congealing Principle is a Spirit of Nitre.*

----- And, *The making of Fat is but the durable congelation of Oil.*

Hence also it appears that Animal Fat it self is but the curdling of the Oily parts of the Blood; either by some of its own Saline parts, or by the Nitrous parts of the Air mingled therewith.

The reason therefore of the difference in the consistence of some parts of the Marrow, and of the congelation of that which is found indurated when it is cold, is the mixture and combination of the Nitrous parts of the Air with it, fixing the Particles of it; which do it so effectually, that if any of the indurated Marrow be distilled *per se*, it will, after it is brought over, and cold, return to its former consistence. Though afterward, by setting of it long in the Sun, I brought some of it to the nature of a true Oil, which remained liquid when it was cold.





Of the USES of the MARROW.

I Shall in the next place give some account of the uses of the Marrow: the uses of it I say, because it serves for more than one; though that can be none of them, which Authors seem to ascribe to it, when they make the medullary substance, which lies between the two Tables of the Skull, to serve for the Nourishment of it. For besides that the Bones have evidently Blood-Vessels designed for their Accretion, which properly belong to their substance, and are no ways concerned with the Marrow; to any one that considers the nature of the *Medulla*, that it is an Oil, it will plainly appear how uncapable it is of being converted into so solid a substance as that of a Bone. Yet if they will suppose Nutrition to be only a supply of Volatile and Fluid Matter, to maintain the fulness, and to preserve the Tone and temperament of the containing parts, the medullary Oil may be said to be concerned in their Nutrition,

tion, as it is continually supplied to repair the loss of that Oil which is expended.

The use of it is, in the first place, general, and common to all the Bones, and to the whole of every one of them; and secondly, more particular to some parts of some of them. It oils the whole substance of every Bone, and by its unctuousity preserves them in a due temperament. Their parts are naturally dry in themselves, and when they obtain too great a degree of ficcidity, they are more fragil, and apt to be broken by any violence; and not only so, but we find how soon the thin part of the *Scapula*, where there is no *Medulla*, will without any violence crack, merely by its own dryness, when it is expos'd to the Air: so that it was necessary, for their security against Fissures and Fractures, that they should be defended by such a Matter as may help to retund the violence of those accidents which are apt to injure them, and so mallify their parts as to make them capable of yielding a little to those pressures and that force which would otherwise be more easily, more inevitably and more sensibly injurious.

Besides this general use of the Marrow, the service of it is more particular to the extremities of those Bones which are articulated: First, for their lubrication, to fit them for the great, and necessary business of Motion,

to preserve them always in a condition fit for it, and to make them more ready to alter their Position, when there is occasion. It is true, the ends of these Bones which are articulated are very smooth, but yet if they were dry, they would not with that readiness and facility obey the commands of those Muscles which move them. Wherefore Nature has taken care to lubricate them with a slippery Oil, to which, when it flows into the Joint, is added a mucilaginous Liquor separated by peculiar Glands, seated in the articulations; and from the mixture of these two, an Oil, and a Mucilage, is made a composition so fit for this design, that nothing taken from the vast stock of Nature seems comparable to it; as I shall shew when I come to speak of the Glands which separate the Mucilage.

Secondly, The medullary Oil, in conjunction with a Mucilage, preserves the ends of the Bones, which are articulated, from an Incalescence, from contracting an inordinate heat by their motions, which would otherwise be the effect of them, especially when they are very quick and violent, and long continued. It is impossible that two Bodies so solid as the Bones in some parts are, and the extremities of those which are articulated, would be, without the benefit of such a Matter as both mollifies them, and intervenes,
so

so as to keep them from an immediate contact, should be violently moved and rubbed one against another without creating a great heat. This every Coachman, every Carman is sensible of, and therefore they have their Oil and Mucilage, a Composition, in which they imitate this of Nature; that is, a mixture of Grease and Tar, with which they besmear the Inside of the Naves of their Wheels, and the extremities of the Axis, upon which they move; without the benefit of which the swift Rotation of one about the other produces a heat, and that sometimes so intense as to set them on fire. And if there had not been a provision in the Joints against such a preternatural Incalescence upon their violent Motion, this would have made a slothful World, and have confined us to slow and deliberate movements, even when there were the most urgent and hasty occasions to quicken us.

Thirdly, It was farther necessary that the Bones should be oiled and moisten'd with something of this nature in their Joints, to prevent their Attrition, or wearing, by rubbing one upon another. For without it we cannot but be sensible and certain of this, that two Bodies of the nature which the Bones are of, being frequently, and as some of them often are, violently moved one upon another,

must inevitably be mutually injurious, and some of the parts must be worn off on both sides; so that the contrivance of Nature, to adapt one Bone to another in all the articulations; to fit them for an easy motion, and that variation of their position which is requisite in every Joint, how admirable soever it might seem at first, would not be long useful, but the stirring part of Mankind would soon find themselves fitter for an Hospital than for Action and the pursuit of Business.

Thus it appears how beneficial and absolutely necessary the medullary Oil is to the Bones: but the use of it extends it self beyond the ~~se~~parts, first to the Ligaments, which tie them that are articulated, together: these it preserves from dryness and rigidity; it keeps them playable and ready to conform to all the motions and postures of that moveable part to which they appertain. Were they not thus oiled, we may easily be sensible how different their temper would be from what it now is, from the rigidity which they contract, when they are laid in the Sun and dried. And why may we not also suppose that it is as useful, and for the same reason necessary to these parts, as Oil to Fiddle-strings, which the Musicians make use of to preserve them from that aptitude to break, which otherwise they will have when they are much extended.

extended. So to secure these Ligaments from a disruption, which, as strong as they seem to be, they would be in danger of, upon a great and sudden stretch or contortion, if they were dry, they are oiled and moistned with this mixture of the medullary Oil, and the Mucilage.

And as it preserves the temperament of the Ligaments as well as that of the Bones, so it serves likewise for their lubrication. Some of them are fastned to the Bone at some little distance from the extreme part of it, that they are distinct and separate from some part of the side of it which they lie upon; so that in all the motions of the Joint they not only are inflected or extended, but they slide backwards and forwards upon the Bone. Now being contiguous to it, and slipping upon it, there does appear a reason for, and a necessity of something which may lubricate them, which might make their motion upon that part of the Bone where they slide, more ready and facil. And from the supposition of a defect of that which should make them slippery, we may account for the cracking of the Joints, which is frequently to be observ'd in some Scorbutical Persons, where I do think that the Ligaments more than the Bones are to be accused: for if they are not sufficiently lubricated, they will not be so ready to slip

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that way which the motion of the Joint commands them; and when they do not slide proportionably, and by a continued motion answer to that variation which is made in the position of the part, they must needs, if they make any stop when the Joint persists in its motion, be extraordinary extended; which seems to be the occasion of that pain which is then often felt, and is one thing that makes me think that the Ligaments have some sense. But being incapable of such an extension as will without their motion give the part the liberty of being extended or inflected to that degree to which the Muscles by their contraction oblige them to move (which would be inconsistent with the due conjunction of the Bones) when they can give way no farther by their extension, they are forced at last to slip, and that with such a quickness as makes the ends of the Bones strike one against the other with a sudden violence, which impresses such a motion upon the Sonorifick Particles of the Air, as affects our sense of hearing: altho' it is probable that there may be another reason for this cracking of the Bones sometimes, and a different affection of the Ligaments to occasion it, that is, too great and a preternatural laxness in them; whereby being more capable of an extension, they do not tie the Bones so close and strictly together,

gether as to keep down the process or end of one firmly into the *Sinus* or Cavity of the other, tho' the relaxation be not near so considerable as to dispose the Bone to any thing like a Laxation. Now supposing one to rise from the bottom of the *Sinus* in the other, in the motion of the Joint the end of one Bone may be pitched against some lateral part of the Cavity, and move upon that as its Axis, and every little irregularity in the position of it makes it incapable of moving so as at the other extremity to describe so much of a Circle as the contraction of the Muscles will oblige it to do, without a restitution to its natural place; which not being done without some force, it falls down with a violence and velocity into the bottom of the *Sinus* of the other Bone, where they strike one against the other in such a manner as to make a sound.

The medullary Oil seems to be serviceable to some other parts besides those for whose benefit it is evidently employed, and where I have shewn the uses of it; and I cannot but think that it is communicated from the Bones in which it is deposited, to those Cartilages which are joined to them, and that for some necessary end. Besides that the Bones are there softer than where the Plates are contiguous in their sides, and there is nothing intervenes to prevent the passage of this Oil out
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of one into the other, there are Pores both in that end of the one and of the other where they are joined together, which allow the passage of it, and seem designed for this purpose. And I have, when they have been relaxed with the heat of the Fire, observ'd an Oil, which had insinuated it self, and stuck to the end both of the Bone and of the Cartilage. These Parts it preserves from growing dry, and maintains their flexibility: and how necessary it is that they should be moistned with something of this nature, appears from the hardness and rigidity which follow upon their being dried.





THE FOURTH
DISCOURSE,
 OF THE
Mucilaginous Glands.

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Proceed in the next place to give an account of a particular sort of Glands, seated in the Joints, which whilst I was making some observations of the several parts which belong to and make an articulation, I came to take notice of, which separate a mucilaginous kind of Liquor; and are no where described, nor have ever, that I know of, been observed by any one: only some time after I had made my Observations of them, I met at Surgeons Hall with an indefatigable and curious Anatomist, one Mr. Cooper, an ingenious Surgeon of this Town, who had taken particular notice of the larger sort of these Glands.

After

After I had considered the nature of that Liquor which presents it self to our observation in the Interstices of the Joints, which I always found to be mucilaginous, I began to think with my self, that as it was vastly different in its Nature from the Marrow, or an Oil *per se*, though it might have the accession of an Oil, it could not be all supplied from the Cavities of the Bones, but must have some distinct and peculiar parts to separate and supply it; which gave me the first occasion of enquiring, whether they were no Secretory Organs, particularly design'd for the separation of it: and upon a strict examination of the Interstice and the Membrane, which does immediately cover the Articulation, I first found in the *Sinuses* of the Bones within the Joint, some soft parts, which to the touch seemed Vesicular and spongiouse; and observed, that the Membrane not only was lax, but also unequal, with protuberances of a different Figure and Magnitude. As it was loose, and easily extented, where the Ligaments would not suffer the ends of the Bones to recede from each other, it was evident that it was not inservient to their Conjunction; nor was this use of it consistent with an Articulation: for, did the Membrane, which lies round the Joint, tie the Bones together, this must have fix'd the part which is

to be moved, on every side, and have made it incapable of a flexure, or any natural alteration of its position. The inequalities I observ'd, presently gave me the suspicion of Glands; and when I came to make a farther enquiry, I found that the Membrane was truly glandulous, and that those soft Bodies which were in any of the *Sinuses*, were Glands; and besides the reason I had from the observation of them to think, that the Mucilage was separated by them, I was fully convinced of the truth of this, when I express'd some of it out of them.

Now because they have not been taken notice of, nor obtained any name, and I shall have frequent occasion to mention them, it will be convenient to impose upon them one which may be proper and distinguishing, and the parts, in which these are seated, and to which they are serviceable, suggest such a denomination as *Glandulæ Articulares*: but because I have observed the same sort of Glands in some other parts, to wit, between the Muscles and about the Tendons; and there are Glands seated in the Throat, which separate a mucilage for the lubrication of our Food, and to make the descent of it into the Stomach more quick and facil, I shall give them a more comprehensive name, such as *Glandulæ Mucilaginosæ*, or the mucilaginous Glands.

In Treating of which I shall first give some description of them, and an account of the Structure and particular situation of those which are most considerable. Secondly, I shall consider the nature and design of the Liquor which they separate, and shew, how so great a quantity of it as is necessary for the use of so many parts, as it is employed in, is continually generated. Thirdly, I shall give an account of some Experiments I made with it; and of a Distemper or two, which owe their Original very much to the Mucilaginous Glands.

These Glands are of two sorts: some are small and numerous in every Joint, which are set thick all over the Membrane, excepting where there are any large Glands, and they are all of an equal magnitude, so as to render it every where glandulous; which is not extraordinary in a Membrane, when we have Tunics which are evidently so: and the sagacious *Malpighi* has discovered to us, that the *Tunica Vaginalis* of the *Testes*, the Membrane or *Capsula* of the Heart, the *Péritonæum*, and *Pleura* are all so. But in some parts of the Membrane, and in the *Sinuses* of the Bones in the Joints, these Glandules are so Conglomerated as to form remarkable Glands, and these I am now to describe. In some of the large Joints there is only one, as in the

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Acetabulum of the Thigh-Bone, which is a very considerable one. In some, as in the Knee, there are four, or five. They have something of a transparency, when they are not discoloured with Blood-Vessels. This they have from their Basis for some way up towards their other extremity, in Horses, and such large Animals, where they rise any considerable height above the superficies of the Membrane; but near to the upper part, and so to the very end, they receive a red colour from their numerous Blood-Vessels: but in Men they are generally every where of a red colour, which is more intense about their termination. They are soft and pappy, but not tender and friable like the glandulous substance of the Liver, and some other Glands of the Body; so that they are not easily broken by a compression, against which injury it was necessary in their Nature to fortify and secure them, because they are seated amongst such parts as are obdurate, and press upon them in their motion, though it be so lightly as not plainly to compress them: neither are the parts of these Glands very easily pulled asunder; and perhaps the mucilaginous quality of the humour, which they separate, may both make their parts flexible, and give them a disposition to adhere to one another, all which opposes their friability. As for their Structure,

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I had a very good opportunity to enquire into it in some of them, which I took out of the Joints of a Horse, that were Hydropical, and filled with a preternatural humour, which distended their Glandules, and made them appear very fair with the help of a Microscope; one whereof was as large as a Man's Hand. They are, as I have said before, Conglomerate, though they do not consist of several *Lobules*, or Bags of lesser Glandules, as some other Glands do, but of several Membranes, superstrated one over another, set thick with small round Bladders, which not only lie contiguous, but tenaciously adhere one to another, as the several Membranes likewise do. And by examining the Mucilaginous Gland in the *Acetabulum* of the *Coxendix* of a Man, after it was dried, I found, (though I did not question it before) that the Structure of these Glands is the same in Men as in Beasts; for I could discern several distinct Membranes, and divide them, which were six or seven in number. So that though the Glandules are here conformed to those of the Marrow, the Lungs, and of some other Glands, so far as to be of the nature of Vesicles; yet the order, in which they are disposed, is very different. By the Pores of these little Bladders the mucilaginous Liquor is percolated and distinguished from the

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the rest of the Mass of Blood, which is conveyed to them by the Arteries; and from them it flows into the Interstices of the Joints by the Excretory passages, which all these Glands have. Blood-Vessels they have a sufficient number of, which, as I observed before, towards the Apex or termination of them, are more numerous, and make them look of a redder colour than at their Basis. Their Veins have not a direct course, but proceed obliquely with windings; and it is a pleasant sight to see the *Anastomoses* of several of these small Vessels, and their various flexures, as they run along in the Gland. There seems to be a particular reason for the obliquity of the Veins in these Glands, from the nature of the Liquor which they secrete: for the Liquor which these Glands separate, obtaining a mucilaginous quality, the Particles of it do not seem to pass thro' the glandular Pores with any great expedition; and therefore these Vessels are formed with such windings, that the return of the Blood by them may be somewhat retarded, and the Particles, which are to be separated, may have more time to penetrate the Pores of the Glandules. The figure of the mucilaginous Glands is various, and accommodated to the *Sinus* or Cavity in which they are seated. Some are not only long, but broad at their Basis, and grow nar-

row towards the top, so as to terminate in an edge; some have a broad Basis, and rise into a sort of a Cone; some are like little Ridges; some like a *Fimbria*; some are broad, and pretty flat.

As for their situation, they are differently seated in the several Joints; in some they stand over against the very Interstice of the Bones, and run in a little way between them, where the ends of the Bones towards that side are not contiguous, but so form'd as in their Conjunction to make an Interstice, and these are commonly in the manner of a *Fimbria*; some are seated in some *Sinus* or Cavity, others planted upon the Membrane which immediately covers the Articulation. In general they are so seated, that they cannot be injured by a compression from the Bones; and yet there is this contrivance, that the Bone does either in the inflection, or extension of the Joint lightly press upon them, so as to promote the Excretion of the Humour which they separate, into the Joints, when they are moved and stand most in need of it. And by this means it seems to be most plentifully supplied, when there is occasion for the greatest quantity of it, and to be proportionated to the present exigence, according to the quiescence or several degrees of Motion in the part, when it is moved. And it is no small security to these

these Glands against the obstructions, which the mucilaginous quality of the Liquor, that they separate, does naturally dispose them to, that they are sollicitated, and the Liquor express'd out of them by the motion of the parts where they are seated.

But I shall give a more particular account of the situation of the large and considerable mucilaginous Glands in the several Articulations. I begin with that of the *Os Occipitis*, and the Atlas, where there are some of these Glands planted round the Tooth-like process of the *Epistropheus*, the second *Vertebre* of the Neck, and one on each side. In both the Articulations of the Ribs with the *Vertebres*, they are likewise to be found; but the largest is in the lower Articulation, and on that side which is next the Cavity of the *Thorax*. These are but small Glands absolutely, tho' they are of the larger sort, that is, they are formed of several Glandules conglomerated, and lying one upon another in several Membranes; and so to be distinguished from those that are but single Glandules, which only stand one by another in the Membrane of the Joints, and make no conspicuous inequalities in it. In the Joint of the Shoulder there is a considerable one joining to the upper brim of the *Acetabulum* of the *Scapula*, just by the tendinous Origination of the *Musculus Biceps*, on

the forefide of it, which runs downwards upon the Membrane for some way towards the Arm-pit. And on the other fide of that Origination there is another at a little diftance from it. In the Cubit there is one Gland feated in the Cavity, which is on the hinder part of the *Trochlea* of the *Os Humeri*, and another large and fair one, in one of thofe *Sinufes* which are on the forefide of the fame *Trochlea*, which I have given a figure of, Fig. I. Tab. II. And upon the *Radius*, and *Ulna* there are fome of them, which lie like a Ridge. At the Articulation of the Bones of the Cubit and the Wrist there are a row of thefe Glands, or one of them lying like a Ridge of little Hills from one fide to the other on the back part. On the infide there are fome, but not fo confiderable. At the Bones of the *Carpus* there are fome, which are like a *Fimbria*. The *Acetabulum* of the *Coxendix* has one of the largeft of this fort of Glands in the whole Body. Where, becaufe the Cavity is deep, and the *Supercilium*, which goes round the brims of it, runs fo far over the head of the Thigh-bone, and lies fo clofe to it, that the Mucilage could not have plentifully infinuated it felf into the Cavity, nor readily have been diffufed for the Lubrication of the head of the Bone, which is received into it, if the Gland had been feated, and the Mucilage fe-
parated

parated out of that Cavity; therefore the Gland, which supplies it to this Joint, is placed within it, and lies between the extremity of the head of the *Os Femoris*, and the *Coxendix*. But as this was necessary, so on the other hand there was a difficulty, and an inconvenience, which without the Providence of Nature, would have attended this situation of it: for if the Cavity had been every where fitted to the head of the Thigh-Bone, which it receives, without a particular regard to this Gland, and the Gland had been placed within it, as now it is, it would necessarily, especially in a standing posture, have been compress'd to the destruction of the tone of its Glandules, and so have been rendered incapable of performing its Office: therefore there is a *Sinus* or Cavity at the bottom of the *Acetabulum* formed on purpose to receive and secure it beyond the injurious pressure of the Thigh-Bone. This Cavity is in a human Skeleton almost of an Oval figure which I have found an Inch and five eighths in length, and in the widest place very near one Inch one eighth in breadth, and about three eighths of an Inch deep, occupying at one end, and on both sides only the bottom of the *Acetabulum*, but at the other end it runs up by the Ligament, which is inserted into the tip of the head of the *Os Femoris* to the brim of

Cavity. In the Knee there are of these Glands both before, and behind: above the *Rotula* there is one, and at the bottom of it another, which is a very considerable one, and on one side another, that is less; all which I have given a figure of, Fig. II. Tab. II. where *A, A, A, A,* are the fore-part of the Knee, taken off with the *Patella*, and the inside turned up and laid in view: *a, a, a,* are the large mucilaginous Glands: *b, b, b, b,* the Membrane which immediately covers the Interstice of the Joint, and *c* is the *Patella*. As for the Glands of the Fingers and Toes, they are seated on the inside, or bending part, where they are like a *Fimbria*; and in every Joint there are two of these glandulous *Fimbriæ*, one belongs to the remotest, or that which is the moving Bone, when the posture of that Joint is altered, and is seated just at the edge of its extremity; the other is planted upon the Bone with which the other is articulated, at a little distance from the extreme part of it, up in a *Sinus*, formed as well for the reception of that Gland, as to give the other Bone, when it moves that way, the liberty of sliding towards it, and of being inflected; at which time it makes some little pressure upon it. And now let any one consider the situation of all these Glands, and he will be sensible how they are seated, as I said, so as to be lightly

ly press'd, either when the Bone is extended, or inflected, to promote the Evacuation of the Mucilage out of them into the Interstice of the Joint.

And here I cannot but take notice, that I have observed the same sort of Glandules in the *Membrana communis Musculorum*, as those, which occupy the Membrane that lies over the Joints in all that part, which has none of the large Glands; and amongst many of the Tendons, there are several of the larger Glands, or the lesser Glandules conglomerated into the form of Glands: so that I dare be positive in this assertion, that the common Membrane of the Muscles is every where glandulous. For in that Subject, where I had some hydropical mucilaginous Glands, I found several parts of the Membrane of the Muscles in the same manner hydropical; where it not only upon an ordinary view appeared like the hydropical mucilaginous Glands which I took out of the Joints of the same Subject, but when I came more strictly to examine the Structure of it with the help of Glasses, which the fulness and distention of the Glandules gave me a fair opportunity of doing, I found that as it had small Vesicles or Glandules, so were they exactly like those of the mucilaginous Glands of the

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Joints:

Joints: there was only this difference, that the Glands consisted of more Membranes.

From the observation of these Glandules, and that hydropical fulness and swelling of them which I met withal, I cannot but conclude, that when we have a Dropsy about the carnous parts, the common Membrane does sometimes contribute to it; and that there it now and then a particular Dropsy between the Muscles, where the water is supplied by these Glands only; part of which flows out of them into the Interstices, and part is retained in the Vesicles, which distends them in an extraordinary manner; and by making a great and preternatural addition to the thickness of the Membrane, produces a sensible swelling in the part.

The larger sort of these Glands about the Tendinous parts are very easy to be discovered, and remarkable in those Beasts which are of a considerable magnitude, especially where there are any long Tendons which slide backwards and forwards in a *Sinus*, upon the contraction and extension of their Muscles.



Of the Nature and Use of the MUCILAGE.

THE use of the Glands, which I have now described, in general is the same as that of all Glands, that is, they serve for the percolation and separation of some Matter, and they do particularly supply a Liquor which is necessary for facilitating the actions of those parts where they are seated.

The Liquor separated by them, is a Mucilage, which is almost like the white of an Egg, tho' it is not always so clear and limpid; yet when it is pure it has the resemblance of it: in some Beasts I have observ'd it to have a yellowish colour, as if there were a portion of Bile in it. It is evidently saltish to the taste, and consists of Aqueous, Saline, and Gummous, or such Terrestrial parts, as have no rugosities or inequalities, nor hamous extremities, so that they are apt to slip one upon another; but withal they have so much of an immediate contiguity, as makes them in some degree adhere; which gives them some-

something of a Viscosity, or mucilaginous quality. The Salt, and Terrestrial parts, I have found to be about a two and thirtieth part of the Composition ; which is more than such a proportion as that must be of Gum Arabick, or Tragacanth, which with fair water will make a Mucilage of the same consistence. The nature of the Mucilage seems to be very much like that of the serous part of the Blood, which shews it self distinct from the fibrous parts or *Coagulum*, after it has stood some time exposed to the Air ; and several mixtures will produce the same effect in both. And it is not strange that one has so much of the nature of the other, when the Mucilage is supplied from the Blood, and is without doubt a part of the *Serum*. But yet that there is a difference, appears in that the *Serum* is not so mucilaginous, and from some experiments : for the *Serum* of the Blood will be more remarkably coagulated with Spirit and Oil of Vitriol, with Spirit of Salt and Oil of Sulphur ; and when they are held over the Fire in a Spoon, the effect is very different : the *Serum*, as it is known, will in a manner turn wholly to a thick Jelly or Size, which is friable ; infomuch that of a Dram I have had, after it had lost its fluidity, two Scruples and sixteen Grains ; and after it was thoroughly dried, five Grains and a half ; which

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is very near the eleventh part: whereas the Mucilage with the heat of the Fire turns for the greatest part into a Liquor more tenuous than it is it self naturally, and produces only a thin film upon the top with some little white *Coagulum*; and what remains, after the aqueous parts are all perfectly evaporated, is not a thirtieth part.

The use of this Mucilage is principally to lubricate the Joints, to render and preserve the ends of the articulated Bones so slippery, that the Animal may move and manage those parts, as there shall be occasion, with the greatest facility. This seems to be the great, but it is not the only thing that lubricates the articulated extremities of any Bones: for besides the Liquor which is supplied by the mucilaginous Glands, which I am now speaking of, there is an oily substance transmitted from the Cavities of these Bones into the same Receptacles or Interstices, by passages formed for this end, as I have shewn in my Discourse of the Marrow. These two meeting in the Joint, are mixed together, especially upon the motion of the part. And certainly there is no Liquor, nor any mixture can be thought of more proper for this end, than this is, where not only both the Ingredients are of a lubricating nature; but there is this advantage from the Composition, that they do mutually

ally improve one another : for the Mucilage adds to the lubricity of the Oil, and the Oil preserves the Mucilage from inspissation and contracting the consistence of a Jelly. And here we cannot avoid the notice of the visible footsteps of an infinite Reason ; which as they are deeply impress'd upon the Universe, so more especially upon the sensible parts of it in those rational contrivances, which are found in Animals : and we can never sufficiently admire the Wisdom and Providence of our great Creator, who has given all the parts in these animated Beings not only such a Structure as renders them fit for their necessary Motions and designed Functions ; but withal the benefit and advantage of whatever may preserve them, or facilitate their Actions.

There are some other ends which this Mucilage is inservient to, as the preservation of the extremities of the articulated Bones from Attrition, and an incalescence ; but because neither of them seems to be the first intention of Nature, in the Generation and supply of this Liquor, and I have taken occasion to speak of these uses, and how it serves to them in Conjunction with the medullary Oil, in the preceding Discourse concerning the *Medulla*, I shall take no farther notice of them than to mention them.

As I have observ'd the mucilaginous Glands seated between the Muscles and about the Tendons, and a Liquor of that nature supplied to those parts by them; so it is not to be doubted but the design and principal use of it is the same as in the Joints, to wit, to lubricate them. And when we consider how the contraction of the Muscles not only obliges their Tendons to approach towards their Origination, but draws up some part of every *Fibre* towards their beginning, so that they must necessarily move or slide backwards or forwards upon the part which lies contiguous to them (which is the *Membrana communis Musculorum*) as they are contracted, or relaxed, and extended, we shall soon be sensible how necessary it is that the Muscles should be lubricated. And for some of the Tendons, which slip up and down in *Sinuses*, as those of the *Musculi perforantes*, which are inserted into the third or last Joint of the four Fingers, and into the same Joint of so many of the Toes, some of the flexors of the Leg, and some others, the Mucilage does appear as useful and necessary to them as in the Joints, so that I need not go about to prove it.

Allowing therefore this Liquor, when it is supplied to the Muscles and Tendons, to be employed in their Lubrication, as it is at the extremities of the Bones which are articulated,
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it will be no unreasonable supposition to think that there is the same kind of mixture in these parts, that there is the addition of an Oil to the Mucilage, to preserve it from inspissation: since the nature of the Liquor is the same in both, there is the same reason in one as in the other; and the matter of Fact does in a manner appear, when we find such vast numbers of adipose Glands, and such quantities of Fat between the Muscles in some Bodies; and in fatted Beasts there are some of the adipose Glands to be observed about the Tendons, which move in a *Sinus*. Though such a collection of Fat does not occur in all Bodies; yet that there are the same Glands in those that are Lean, does not admit of any dispute: nor is it less certain, that they perform their Office, and separate a Fat, so long as there are oily parts in the Blood, which in the Circulation of it will offer themselves to those Glands. And altho' the reason of leanness in some Men may be, because the quantity of Oil which is separated by these Glands, is not so great as in those that are obese; which seems to be the reason in old Men, in sickly persons, and in those that feed high, and use but little exercise, yet are of a thin habit of Body: yet that which makes the variation between fat and lean Bodies, is often a difference in the expense of this Oil. The design of which being to as-

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sist in the Lubrication of the Muscles and Tendons, it follows, that it must be more profusely expended, where their motions are frequently repeated, or long continued. Therefore there are many in the World, as those whose Fortune condemns them to hard Labour, and have little Rest but the Repose of the Night, that cannot shew such larded Muscles as some others can (as I do not know that ever I saw a Country Labourer Fat) who notwithstanding have better Appetites, enjoy such a perfect state of Health, and carry all the signs of the good Crasis of their Blood, that we have no reason to question but the Mass of their Blood supplies that proportion of Fat which would make them as Corpulent as some of their Neighbours ; but that the laborious manner of their life makes them have some other occasion for it, and the motion of their Muscles is a way by which it is continually expended, so that there is no overplus to be reserved in the adipose Cells. And how often do we find an alteration in the plight of these Men, when they can indulge their ease, and allow themselves in a more idle way of living ? How evident is this in Horses, which, whilst they rest and are well fed, grow Fat ; but when they come to be rid, or to work hard long together, spend all that stock, and lose their Flesh, as it is termed, so as to be almost

most a shame to a Market? That there is a greater expence therefore of the Fat upon great motions and exercise, is plain: the question then will lie here, how this Oil is employed. Dr. *Mayo* supposes these sulphureous parts to be separated from the Mass of Blood by the *Parenchyma* of the Muscles, and by a congress with some *Nitro-aereous* Particles or the Spirits, convey'd to them by the Nerves, mutually exagitating each other, and producing an effervescence to serve for the contraction of the muscular Fibres; and in case the Muscles are not frequently exercised and contracted, so as to employ all those sulphureous, or, as he makes them, *salino-sulphureous* parts in their motion, and so to destroy them, that then they are convey'd by peculiar Ducts from the interior part of the Muscle to convenient Receptacles; in which we afterwards find them collected in the form of fat. And to strengthen the probability of this Hypothesis, he urges this as an Argument, that these parts are separated in the *Parenchyma* of the Muscle; that the Blood-Vessels which are diffeminated through the Body of a Muscle, are never propagated so far as the Fat: so that the parts which constitute it, cannot be immediately supplied from them to those parts in which we find it. But this Argument may be easily invalidated.

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For altho' it is true the Blood-Vessels in the Fat are not so numerous as in some other parts, yet there are some which are visible; and Glandules, which serve for the separation of those oily Particles. Besides, I have observ'd some adipose Glands about the Tendons, at a great distance from the fleshy Fibres: and we find in the Cavities of the Bones a substance of the same nature; where it certainly is neither separated by the *Parenchyma* of any Muscles, nor concurring with the Spirits in their contraction, but some part of it is assigned to the Joints, where it meets with the Mucilage; which necessarily requires something of this nature to preserve it from inspissation: which if it be requisite for this end in the Joints, is no less in any other part, where the Mucilage is employ'd. But if these sulphureous parts are expended and destroy'd in the contraction of the muscular Fibres, then must they be wanting to this Liquor, when it is most plentifully supply'd, and there is the greatest occasion for them upon the external part of the Muscle: so that I rather think, that the first intention of this Fat is to make such a Composition as is fit to lubricate the parts, and all the uses of it are in Conjunction with the Mucilage.

Besides the intention of Lubrication, the Mucilage with the addition of an Oil is farther

necessary to the Muscles and Tendons, to preserve them from shrinking, from growing dry and rigid. Therefore in Rheumatisms, when the nature of it is altered, and it contracts such a viscosity and thick consistence as render it unfit to moisten these parts, we have a stiffness and Stupor ; which I shall take farther notice of when I come to speak of that Distemper.



Of the Generation of the MUCILAGE.

HERE some may be so curious and inquisitive as to ask me, how the Mucilage is continually generated, and how the sanguineous Mass comes to be capable of supplying such large quantities of it as are necessary to lubricate so many parts, as it is constantly, tho' not always in the same measure, supplied to. I answer, that the matter of which it is made, is originally from our Food, and the Chyle, which is daily added to the Mass of Blood, as all other Juices are ; but yet it is a great alteration, which those parts, of which it is generated, do undergo, before they are reduced to
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the true nature of a Mucilage. The change therefore which that part of Blood, from which it is produced, undergoes in order thereunto, seems to be made by some Gland; and there is none, that I can think of, which seems so fit and likely to be concerned in this affair, as the Spleen; which I suppose to be the *Officina*, where Nature produces and elaborates the Mucilage; from whence it is administered to the Blood, and by that dispensed in its Circulation to all the parts about which it is necessary it should be employ'd. This I have been thinking, that this large *Viscus* is designed for such an Office; that it is not absolutely necessary to the life of Animals; since we find not only that the privation of it is consistent with Life, but that the Animal has seem'd little concerned for the want of it. And this not only has been observ'd in Dogs, which are the ordinary Subjects of this experiment; but there are some that tell us, if we may give credit to what they say, that it has been found wanting in some Men, and taken out of others, who have been restored to their Health by a happy Cure. Thus far this Gland, and the use which I assign to it, agree; since the Office which I suppose it does perform, is not so requisite to the being, as the convenience and well-being of an Animal. For altho' the Mucilage did wholly depend upon the Function

of this part, we may easily satisfy our selves how it comes to pass that the Animal is no more injured by the want of it. For since the use and design of it is to lubricate the parts; and there are no parts, about which it is employ'd, but have an Oil that answers the same end, supplied to them, the inconvenience which we may suppose should follow upon the want of the one, is very much taken off by the other, which is likewise of a slippery and lubricating nature. Though I am apt to think, if the Animal, after it is deprived of the Spleen, were put upon great and frequent motions, there would appear a more sensible injury from the want of it: and because the Subjects, in which this Experiment is commonly made, have not been afterwards put upon stirring; but being fit for no farther use, or reserved only for dissection, have been allowed to lie at home, and to live a lazy and soporose life; therefore they have had less occasion for the Mucilage, and so have seemed unconcerned for the want of that part which supplies it. And as I make this an Argument for my Hypothesis, that as the Spleen, so the Mucilage is not absolutely necessary to the conservation of life, so the quality of that matter of Juice, which is always found in the *Parenchyma* of the Spleen, does give us some reason to suspect, that it is designed for
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the generation of this mucilaginous Liquor. For that it contains and exhibits such a kind of Juice, there is no Man that has his Senses, and examines it, can deny. And why does it produce such a Liquor, if not for the service and benefit of those parts which do stand in need of it, and are evidently supplied with a Liquor of such a nature, as the Juice, which is found in the Spleen, is of? Besides, considering of how great and publick use the Mucilage is to most parts of the Body, it is not strange that a *Viscus* should be formed and designed particularly for the Generation and Elaboration of it. Moreover, from this supposition, as this Gland has no common Receptacle to entertain, nor proper Ducts to convey the Humour which it separates, to other parts, we may easily see the reason why it has neither: one was inconvenient, and the other in a manner impossible. It was not convenient that this Liquor should be carried into, and reserved in any Receptacle, in or about the Spleen, because it stands at a great distance from most of the parts to which the Mucilage is necessary; so that if it were deposited in any such large Cavity, it could not be immediately supplied upon any occasions that are extraordinary or sudden, as our motions oftentimes are. And for Ducts, it seems next to an impossibility that the Spleen should have so many as

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would be necessary to convey the Mucilage to all those parts which stand in need of it; whereas, by what I suppose, the thing is done without them: for by the Communication of it to the Mass of Blood, it is brought into a method, in which it is dispensable to all the Joints, the Muscles and Tendons, and whatever parts can be thought to require it; since the Blood, with which it afterwards Circulates, has its motion through all the parts of the Body, and in its Circulation flows to all the Glands by which the Mucilage is separated in every part.

I will go farther yet; and now I have endeavoured to prove, that the use of the Spleen is to generate this mucilaginous Liquor, I will attempt to explain the manner, how it does it; which was a thought suggested to me from what I accidentally observed when I was about making one Experiment with the Mucilage. Designing to try what alteration an acid-austere would make in it, I mixed some Spirit of Vitriol with some of the Decoction of Galls, and I found, that the mixture produced a soft and perfect Gum. Now as there are evidently gummous parts in the Mucilage, so in the Spleen there seem to be supplied from the Blood two Principles, of the same nature as those were of, of which I made that Gum, that is, an acid and an austere, to produce it.

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The Spleen having a sub-acid tast when it is boiled, as *Diemerbroeck* has observed, does discover an acid in it. I do therefore suppose, that the Splenick Glandules, being formed with two colatory Pores, do by one separate an acid, and by the other an austere Juice: which, meeting in their small Cavities, the one does precipitate the other in the same manner as the Spirit of Vitriol did the Decoc-tion of Galls; not into a plain and perfect Gum, but, as the degree both of the acidity and austerity is low, only into a more thin Mucilage.

The nature and use of that Liquor which is naturally separated by the mucilaginous Glands, however it is first generated, are such as I have described. But as other Glands of the Body, so these, do sometimes separate and take off from the Mass of Blood a morbifick Matter, which, because it is not excerned out of the Body, but is thrown upon, and lodged in some parts which are affected and injured by it, does excite some particular Symptoms wherever it is deposited. Therefore, all the parts where any of these Glands are seated, must be obnoxious to Catarrhs, when ever they are disposed for the separation of that Matter which is Heterogeneous and Morbi-fick, and Nature makes an attempt to depu-rate the Mass of Blood by them. Now as these

Glands, as I have shewn, are seated both between the Muscles and about their Tendons, and in the Interstices of the Joints, so this dissolution of Matter happens sometimes to one, sometimes to the other, and sometimes to all of them; which, when it is excluded from the Mass of Blood by those mucilaginous Glands which are seated between the muscular parts, produces a Rheumatism; when by those which serve to the Joints only, and the Tendons, which are inserted near them, procures the Gout. I shall therefore say something of both these Distempers. But before, and in order to the explaining of the Nature and Cause of them, I think it necessary to give an account of some Experiments which I made with the Mucilage, which is the Liquor naturally supplied to, and always entertained in those parts which are affected in these Distempers. This I proposed to my self, that as the humour, which is the cause of them, is morbifick, and mingles with the Mucilage when it is thrown into the same Interstices; so the alterations, which I might observe from several mixtures, made with the Mucilage, where they agreed with what we often observe in these cases, would discover both the nature of that humour, which is then the cause of these Distempers, and the reason of some Symptoms which accompany them.

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The trials which I made with this Liquor by mixture, have been many, and more than I shall here take notice of, because there were several which did not succeed so as to make any sensible alteration in it. The Mucilage which I made use of, I had from the Joints of Oxen, and of a Horse; which being large Animals, did afford sufficient quantities for my purpose. I made most of the trials both when it was hot and when it was cold. Vinegar dropt into it, when it was hot, made a considerable Coagulation, with a *Serum*; to all which I afterwards added the powder of Coral, both because it is esteemed a Specifick in a Rheumatism; and I thought the effervescence, which would follow, might dissolve some part of the Curd which the acid had produced: but I found no such effect from it, nor from *Antimonium Diaphoreticum*, Crabs Eyes, nor any thing of a testaceous nature, that I tried. All the following Experiments I made with it when it was cold: I made the same when it was hot; but because to give a distinct account of both of them, would be little better than a Tautology, I shall only observe, that those which were made with it cold, did produce the same effect when it was warmed, to wit, a Coagulation, with Acids and Stipticks, only in a higher degree. And whereas the Coagulations

lations which were made when it was in one state, did only change it into a thick Jelly, without any *Serum*, after the manner of a Cheese, when it is newly set, as they term it; which over the Fire afterwards exhibited two distinct parts, a *Coagulum*, and a Whey: in the other, that is, when the Mucilage was hot, the mixtures which coagulated it, produced a harder Curd, and a *Serum* distinct from it. By dropping in some of the Decoction of Galls to some of it, I turned the whole into a gelatinous Mass, and it was all a sort of *Coagulum*, like a skin, of a whitish colour, and so tough as to hang all together, when I took it up with a Needle. This *Coagulum*, or Jelly, being laid in the Sun, and dried, the parts of it stuck all together in one piece, but was very friable, and easily rubbed to a powder, which was very much like fine flower. The same effect had the strong infusion of *Balaustia*, Red Roses, Pomegranate-Pills, and the *Peruvian Bark*; altho' there was some difference in the Coagulation according to the different degrees of their astringency. With a few drops of *Aqua Fortis* distilled upon it, the Mucilage was immediately coagulated; tho' the *Coagulum*, which was white, was so tender that it would by agitation be dissolv'd in fair water, and make it of the same colour, almost like Milk. Spirit

rit of Nitre made exactly the same alteration in it, as *Aqua Fortis* did, a *Coagulum*, which was of a white colour. From which *Phenomenon* I shall afterwards endeavour to give the reason, why the injuries of the Air, and taking cold, are so frequently the occasion of the Gout and a Rheumatism. Vinegar, Spirit of Salt, of Vitriol, Oil of Vitriol, and of Sulphur, in some Mucilage which I tried it with, did not make any considerable alteration when it was cold; but in some other it did more, when *Aqua Fortis* and Spirit of Nitre did produce in all the same effects in the same degree. And I could not but admire to see, that so strong an acid, as Oil of Vitriol, should have no greater effect upon it to alter it, not so considerable as that of Vinegar; which makes me think, that it is not always the high degree of acidity that works this change; but there seems something particular in Wines, which disposes them to coagulate this Liquor, when any of them are made use of, and those parts of them which are apt to act thus upon it, are cast into those Interstices, where they have the Mucilage singly to work upon. And therefore we find how readily any Wines do procure the *Paroxysms* of the Gout, where the tone of the Glands is weakned, and the Patient has a disposition to this Distemper, which agrees with those trials

I made with some of them. For Claret, White-Wine, and even Sack, but the Claret especially, did make a *Coagulum* in the Mucilage like a Jelly. And it was not strange, that Claret, which has both an Acid and a Stipticity in it, should produce the greatest Coagulation. A mercurial water, made of Sublimate and *Aqua Calcis*, made a very considerable whitish Coagulation, and render'd it all a thick Jelly; which being held over the Fire, turn'd to a Curd, and a *Serum*. A Solution of *Roman Vitriol* produced a Coagulation likewise: so did Alum, dissol'd in Water; but it made a greater alteration in some, than it did in others, tho' the Mucilages were taken from subjects of the same Species. *Saccharum Saturni* did inspissate it, which appeared to be a true Coagulation; because with the Fire they would turn to a distinct *Coagulum* and *Serum*. Salt of Wormwood made no sensible alteration, only it seem'd a little thicker; to which I put some of the Decoction of Galls, which immediately produced a Coagulation. Then I dropt in some Spirit of Vitriol, to see what would be the effect of the Colluctation of the Salt and Spirit; and I found, after it was over, that the *Coagulum* and ferous part were distinguish'd, and the *Serum* limpid, like Water. I took some of the Decoction of Galls,
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and added to it Spirit of Vitriol, intending to make a strong acid-austere, where I observ'd that these two by themselves produced a Coagulation; and stirring of them together, to see if the whole might not be brought to mix by that means, I found the *Coagulum* turn'd into a viscous Body, and a perfect soft Gum. Then I took out the Gum, and poured some Mucilage to the residuous Liquor, by which it was chang'd so as to assume a whitish colour, but was not considerably coagulated; which it was the less, because the austere parts were most of them with some of the acid precipitated into the Gum which I had separated from the ferous part. But if the Spirit of Vitriol and the Mucilage are first mix'd, and the austere Liquor be afterwards added, they make a considerable and plentiful *Coagulum*, which will only be broken into smaller parts, and not be dissolved in water. *Aqua Fortis*, and the Decoction of Galls being both dropt into some of the Mucilage, made a white *Coagulum*, which likewise was not dissolvable in water, although with *Oleum Tartari per deliquium*; and so with Spirit of Salt Armoniack dropt upon it, I presently dissolv'd it. I found likewise, that the *Coagulum* made with the infusion of Pomegranate Pills, Red Roses, and *Balaustia*, being mix'd with some of the Mucilage, to which an acid had been put,

put, made the *Coagulum* more firm, so that it would not dissolve in fair water; but yet the *Oleum Tartari per deliquium*, and the Spirit of Salt Armoniack did the Business in all of them. The *Coagulum* of the Mucilage, made with an acid, and the infusion of the *Peruvian* Bark, and several other Astringents, I kept and dried; which when they were first put to the Teeth, seemed a little gritty, though after they were moist, they were of a softer nature. I cannot but take particular notice, that all the mixtures made of the Mucilage with an acid and an austere, produced not only a plentiful Coagulation of a white colour, but such a one as was of a thicker consistence, and not dissolvable in fair water, as that was which was made with an acid only; because I shall have occasion to make use of this observation, when I come to explain the manner how the *Tophi* are produced in a nodose Gout.

And now I come to give an account of some ill Offices which the mucilaginous Glands sometimes perform to those parts, where they are seated; which being, as I said before, either about the Muscles, or in the Interstices of the Joints, do in the one conspire with other causes to procure a Rheumatism, and in the other the Gout. And first,



Of a RHEUMATISM.

I Must own, that this Distemper, having its seat in the Muscular parts, may seem to lie out of the compass of my Argument, as my Discourse has a respect to the Bones; but as I am now concerned with the mucilaginous Glands, it lies so in my way that I should think my self guilty of the neglect of some part of my business, if I should not take this occasion to offer something concerning it. And what I shall say of it, is to be understood of a true Humorous Rheumatism: for that which is Scorbutical, being nervous; and these Glands seeming to be innocent, and to have no hand in it, my Discourse concerning them does not lead me to consider it.

That a true Rheumatism is caused by a flux of humours to the parts affected, is universally received and understood by Physicians; and this Notion agrees not only with the Sense which they have of it, but with the Name too, which they have given it, tho' the manner in which the morbidick Matter is
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thrown upon the parts affected, has never been truly explained; nor could it be known without the observation of these mucilaginous Glands seated amongst them. My business therefore shall be to enquire both what the nature of the humour is, which causes it, and what way it is convey'd to the parts which it affects: from both which consider'd, I shall endeavour to account for the Symptoms of this Distemper.

The Humour cannot be thought to be the Mucilage it self, in its proper and natural State; for it is too mild and inoffensive to the tenderest and most sensible Fibres, otherwise we should be naturally and continually afflicted with this Distemper in some degree or other. Nor can we suppose, that the Mucilage does at that time, when a Rheumatism happens, degenerate in the Blood into any such quality, as makes it acrid or pungent to the parts: for then all the parts of the Body that have Glands, which separate the Mucilage, must necessarily be affected at the same time. It is therefore a preternatural, a morbidick Matter, distinct from the Mucilage, lurking first in the Mass of Blood; which being dangerous and uneasy to Nature, irritates the powers of it to purge the Mass of Blood from it. But yet it does not seem to be the same in all Rheumatisms; but that difference

rence which may be conceived to be in the Humours that are capable of exciting such pains, may rationally be supposed to be in that which is the cause of this Distemper; which I therefore judge to be of three sorts. Sometimes it is acrious and more subtle, and of such a nature, that tho' it procures an acute pain, and is almost intolerable to the sensible Fibres, yet it does not coagulate nor inspissate the Mucilage with which it is mixed, when it comes into the Interstices of the Muscles; as things of that nature will not do it out of the Body: but because it is hot and volatile, and so not only distends the parts by its influx, but disorders the Spirits, and agitates the Particles of the Blood, which by its quantity, and the compression of the extremities of the Vessels it obstructs, there arises a heat, and a greater inflammation in the parts which swell. This matter is easily and quickly translated from one part to another; so that the swellings, especially before the inflammation arises, are not so permanent, nor the pain so firmly fix'd in any one part; but wherever it is, it gives the sense of a burning and fiery quality.

Sometimes the matter is Saline, where, tho' the fixt Salt, as I observed of Salt of Wormwood, may a little inspissate the mucilaginous Liquor, yet it does not give it such a consistence as makes it certainly and pertinaciously

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fix, tho' it moves up and down with less quickness; and the pain does not so frequently shift its seat, as when the matter is acrious and more subtle: besides which, the sense of it is different, as it is pungent and lancinating.

But then, thirdly, it is sometimes, and most commonly, an Acid, or kind of Corrosive: In which case, tho' the matter, whilst it is in the Mass of Blood, be not thick and gelatinous, yet when it comes to be separated from the sanguineous Mass, and to be mix'd with the Mucilage in those parts where the Mucilage is deposited, it coagulates it, and makes it a sort of a Jelly, in the same manner as it will be altered by Spirit of Nitre, and other Acids. And it not only appears from most of those Experiments, which I have mentioned, that the mucilaginous Liquor may be thus coagulated in the Body; but in some Rheumatical cases it is evident, that it is so. I will not insist upon what may be frequently observed from the application of Vesicatories in this Distemper, how there appears, when the Blister is raised and taken off, under the *Cuticula*, a tough Jelly, like a thick skin, which I have afterwards dissolved, because this may not pass for demonstration; but I have met with the account of one case, which does undeniably prove it: it is in a College of Practice, read by Dr. *Drelincourt* at *Leyden*, where he

he says, he himself, in a Person that died of a Rheumatism, found a Jelly, concreted upo the superficies of the Muscles, of the thickness of two or three Ducats. And I had lately the opportunity of observing one Chyrurgical case, and the account of another, from Mr *Edward Bulkley*, a curious, and observing, and skilful Surgeon of this Town, which confirmed me in my opinion. The Patients were both of them his. They had a large Tumor in one of the Thighs; which he, finding a fluctuation of matter, opened by a Caustick, and there ran out a large quantity of matter; some Ounces of which I saw, as it was taken from one of them, and it was not any thing like a *Pus*, but plainly like Milk, turned to a Posset, consisting of some pretty large, and many smaller pieces of white Curd, mixed with a *Serum*, and was lodged in the Interstices of the Muscles, where the Mucilage is separated and deposited. Now as my observation of the mucilaginous Glands about the Muscles may inform us, what way the morbidick humour was brought thither, and my Hypothesis does explain the manner, how the matter, which was found, was generated there; so these observations do seem to me clearly to prove what I would argue for: that the Mucilage is sometimes coagulated in the Body, whilst the Matter is animated; especially when I consi-

der how exactly it agreed with some alterations I found in the mucilaginous Liquor, from some mixtures I made with it, when I had made it hot.

When the quality of the morbid matter is acid, and the Mucilage is coagulated, the pains are more fix'd, so that, tho' they arise in some other parts, yet those which were the first Fruits of the Patients misery, continue immov'd, the pains are corroding; so that we have these Patients complaining of a gnawing (so they are pleas'd to compare it) as if Dogs were tearing of their Flesh: and this is that Stubborn and Chronical Case, which sometimes persists for half a year, or longer, and it may be is never overcome by all the Art and Instruments of Physick. But yet as there is a difference in the nature of the acid, and the degree of acidity, so the degree of the Coagulation is sometimes less, and sometimes greater; and consequently the Distemper is with more or less difficulty vanquish'd.

It is very probable, that sometimes there is the addition of an austere, which conspires with the acid to coagulate the Mucilage, and then, as the consistence of it is rendered thicker, so it is more tough and difficult to be dissolved, which makes the case more Stubborn and Chronical. However, I do not think it is at any time an austere only, when the pains are acute.

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The way of conveyance, by which this humour, whatever the nature of it is, is derived to the muscular parts, is by the mucilaginous Glands, and that in the manner of a *Crisis*; so that the preternatural Humour and the Mucilage are cast into the same Receptacles, into the Interstices of the Muscles, where they will come to be mix'd together: and if the morbifick matter be an Acid, Experiments tell us, that the consequence will be a Coagulation.

The first occasion of this Distemper, is known, to be generally the taking of Cold; and then it seems to be from a nitrous acidity, and such a kind of Spirit in the Air, as destroys the due mixture of the parts of the Blood, fixing the Spirits and those Volatile parts, whose motion and activity do naturally so agitate all the rest, as to confound one with the other, and to preserve those which are of the same nature, from running together; which is the mixture of the sanguineous Particles. And when the Air is in an extraordinary degree impregnated with such a Spirit, then is this Disease more frequent and Epidemical.

That the Air does consist partly of a Nitre, or nitrous spirit, is of late an Opinion so generally received, and so strenuously defended, that he is almost thought a Heretick in Philosophy that denies it. Now that this nitrous

spirit may be admitted into the Body, even by the Pores of the Skin, I do not see how any one can question, who considers how the parts of Mercury, how those of oily Liniments and Ointments, which are more gross, will insinuate themselves this way. Being therefore received in such a quantity as to precipitate the Blood, and to produce a serosity in it, it Communicates, as coagulating Liquors will do, its own quality especially to the *Serum*; which being thus altered, becomes apt to coagulate the Mucilage, when they meet together in the same Cavity: tho' I do think, that when any Rheumatick pain seizes any part upon the immediate influence of the Air, as when it does affect that place particularly upon which the cold Air strikes in an unusual manner, it does more immediately affect the Mucilage, by penetrating thro' the Pores of the parts into the very Cavities or Interstices where the Mucilage is deposited. And that such a nitrous spirit of the Air will coagulate this Liquor, when it either mingles with it *per se*, or Communicates an acidity to the *Serum* of the Blood, and is conveyed to it in that *Vehiculum*, we may be sensible from that Experiment which I made with the Mucilage and Spirit of Nitre.

The taking of cold, as is evident, does alter the *Crafs* of the Blood so, that some parts
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of it lose their due mixture, and degenerate so far as to become unfit ever to be intimately and amicably mix'd with the sanguineous Mass again; and thereupon Nature uses her endeavours to exclude them, that they may neither destroy the *Diatheſis* of the Blood, nor continue to disturb its Circulation. Therefore it is obvious to our Observation, that there follows either a Fever, which is only an attempt to overcome and exclude that Heterogeneous Matter, which endeavour is more sensible and protracted, because the matter is not excluded by any Glands, which perhaps may therefore be retained in the Blood; because the Particles of it are not yet accommodated to the Pores of any Glandules: and as the violent commotion in the Mass of Blood at that time is in order to expel them, so we may suppose it is no less to break, and so figure them, that they may be capable of being excerned by some Glands, which when it is once done, there follows a *Crisis*. I say, there follows either such a Fever, or some Evacuation. Sometimes Nature is so intent upon this affair, and so violent in her attempts to throw off this matter, as to sustain the loss of her own Treasure and the purer parts of the Blood, in the exclusion of those which are Incongruous and Morbifick; as when the *Crisis* is made or endeavoured by a Hemorrhage:

but commonly this is done without that expence, and then it is by the glandular Sluices, but not always by the same; sometimes by those of one sort, and sometimes by those of another, according as they are disposed to receive and separate the morbid Particles. Therefore, upon a Cold we have sometimes a *Crisis* by the Glands of the Nose, as in a *Coryza*; or by the salivatory Glands: at another time by them of the *Trachea* and *Bronchia*, as in a Cough, or Catarrh upon those parts; sometimes by the cutaneous Glands, and sweating; sometimes by those of the Intestines, and a *Diarrhæa*. Neither are the mucilaginous Glands always excused, but the Mass of Blood exonerates it self by them, by which the morbid humour being separated, it is necessarily cast upon the Muscles and Tendons, where the nitrous Spirit, Communicated from the Air, and the matter depraved by it coming to act upon the Mucilage singly, doe inspissate it, and produce that Distemper which we call a Rheumatism.

Although this Distemper does often owe its Original to the preception of Cold, yet it is sometimes contracted from other causes, and occasioned from the liberal drinking of Rhenish-Wine, and those Liquors which are in the same manner acid. Neither have we any reason to wonder at it, when we consider

der the nature of the Blood, and the Chyle, which does daily feed the Vessels, and repairs the sanguineous Mass. I need not go about to prove, that the Chyle is of the nature of Milk, since the Opinion has generally prevailed, that Milk is the very Chyle, conveyed to the Breasts either by the Arteries, before it is assimilated to the Blood, or by more immediate Ducts. And Experiments do tell us, that they both undergo the same alteration from the mixture of an Acid. What must we then think of the Blood, which is every day renewed and maintained by it, but that it borders upon the nature of it? so that since four Liquors do produce a serosity and a Coagulation in one, we must expect they will make an alteration in the Blood, which is somewhat like it, tho' not in the same degree, especially if we drink plentifully of Liquors that have much of an acidity in them, whilst the Chyle retains its lacteal nature, and before it is assimilated to the Blood. And I knew one, in whose cure I was concerned, who was Scorbutical, that upon the drinking of sharp Wines, such as White-Wine and Rhenish, especially at that time when some of the Chyle was yet in the lacteal Vessels, and whilst that which was newly supplied to the Blood-Vessels, was milky, would find the same effect as from the injuries of the Air, to wit, plainly a Cold,

Cold, for so I must call it, in his Head, and a *Coryza*. And when we find these Wines so Diuretick, it argues something like a Coagulation, which causes many of the serous parts to lose their mixture, and disposes them to a separation.

When these parts are so altered and once deprived of their due mixture (as they are never again, or not easily to be reduc'd to their natural state, nor in that which they are in, consistent with the good *Crafsis* and regular motion of the Blood) they become a peccant and an offensive humour; so that the business of Nature then is, as in a Cold, to extrude them from the sanguineous Mass. And what is that plentiful excretion of Urine, which commonly attends or follows the liberal drinking of such Liquors, but a kind of critical Evacuation of *Serum*, or a depuration of the Mass of Blood from some parts of it, which, when they are precipitated, and have lost their due mixture, agree better with a Chamber-pot than the sanguiferous Vessels.

As the serous parts, altered by the nitrous Spirit of the Air, so neither the acid Liquors which we drink, nor the *Serum*, precipitated by them, are always separated by the same Glands. Tho' this separation is often by the Kidnies, yet sometimes it is made by those which supply the *Saliva*, especially in some

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Scorbutical Persons, which I have often observ'd : sometimes these Liquors not only increase a Cough, and heighten the Symptoms of it, which, experience tells us, will be the effect of our ordinary drink ; but they sometimes produce a Catarrh upon the Lungs; and sometimes it so happens, that the morbidick Matter is thrown upon the mucilaginous Glands, which having the convenience of exonerating themselves, cast it off into the Interstices of the Muscles and Tendons. Being deposited in the Receptacles, if I may so call them, of the Mucilage, it mixes with it: and as we see that the Acid, which produces a *Coagulum* and a *Serum* in any Liquor, Communicates its own quality more especially to the *Serum*, so these Wines, which cause a kind of Coagulation in the Blood or Chyle, will impregnate those ferous parts, whose due mixture they destroy, with an acid quality, and render them of such a nature, as that they will coagulate the Mucilage when they come to mingle with it, as I have shewn that these Wines themselves will do it.

Altho' the humour, thus separated, does produce a new Distemper, it is no more improper to call it a *Crisis*, than Buboes, and the swellings of the *Parotides* in Pestilential Fevers. For tho' it be not so in respect to the whole Body, yet in respect to the Mass of
Blood

Blood it is. And I have observ'd where a Rheumatism has been evidently critical; as particularly in one Patient I had, who laboured with a Fever, in the Declension of which there came on a Rheumatism in her Arms, which without doubt was one thing that solved it, as Nature excluded from the Mass of Blood part of that Matter which before had disordered it; by the mucilaginous Glands of those parts.

The Symptoms of this Distemper may be easily and fairly accounted for from the nature of the Matter, and the causes of it, as I have explained them, and the manner in which I have supposed it is produced. They are generally a swelling of the parts affected; sometimes with a redness, severe and acute pains; there is commonly a Fever, a rigidity in the parts, and sometimes in the declension a Stupor and Stiffness.

For the first, the Tumours, they must necessarily attend this Disease, if it be caused in that manner in which I have endeavoured to prove it is. For when the morbidick Matter is plentifully separated by the mucilaginous Glands of the Muscles, and cast into the Interstices, it cannot but distend and raise those parts which lie above it. And besides, what is lodged in those Cavities between the Muscles, the Catarrh or vast influx of the Humour,

mour, will in an extraordinary manner fill and distend the Glands themselves, and so far increase the thickness of the *Membrana communis Musculorum*, as to cause a sensible elevation of the parts which lie over it. Thus we see the Glands on the inside of the Nose in a *Coryza* are sometimes so distended, the Membrane of the Nostrils so tumified, that the passages are stopt, and we are oblig'd to find another way for the inspiration and expiration of the Air. And such a swelling and thickness I observ'd in those parts of the common Membrane of the Muscles which I found Hydropical.

With the influx and plenitude of the morbidick Matter, conspires that which follows upon it, an obstruction in the Blood-Vessels. This is evident, that a small compression upon the Vessels, where they are minute, will force one side of them to be contiguous to the other ; and where the compression is great, as it must be where there is such a preternatural fulness and swelling of the adjacent parts, we may well suppose the Vessels to be so obstructed, that the Blood can at best but with difficulty Circulate thro' them : so that the continual appulse of it flowing more plentifully and freely into them than it can proceed into the Veins, will swell and distend the Vessels in which it is obstructed ; as we see the Veins will

will be tumified below a Ligature; and in an *Ophthalmia* we find the obstruction of the Blood will so enlarge the Vessels as to make them appear visible, which were before indiscernable.

The reason of the pains we may be able easily to understand from the Nature which I suppose the morbidick Matter to be of. When it is either Saline and pungent, acrious and urent, or acid, and akin to a Corrosive, it is sufficient to excite such pains; and we can expect no better treatment from it, when it falls upon such sensible parts as the Muscles and Tendons, and the *Membrana communis Musculorum*. Besides, the sense which arises merely from the quality of the Matter, the copious influx of it into the parts affected stretching the Fibres beyond their natural tone, does affect them with a dolorifick sense, at least, by making them tense, it renders them more sensible of the pain excited by the Salt, the acidity or acrimony of the humour, which is more intense or moderate as the quantity of the matter; and the degree of its quality are greater or less.

The Fever, which is another Symptom that commonly attends this Distemper, does first arise from the Heterogeneous nature of the morbidick Particles, and their unfitness to be mix'd with the Mass of Blood, at which
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time it is mostly an effort of Nature to expel them, but afterwards it is continued by the acuteness and severity of the pains exagitating the Spirits, and producing a disorder and a tumultuous violence in their motion; which they Communicate to the Blood, as they have a continual influx into it, to invigorate it to promote its Circulation, and to preserve the mixture of its parts. And to this Fever something may be added from the compression and obstruction of the Blood-Vessels: for when the free Circulation of the Blood is hindered in one part, it seems obliged to move quicker in others; as we see in a River, dividing it self into two Channels, if one of them be stopped up, the motion of the Water will be more rapid in the other.

Besides the rigidity which necessarily follows the swelling and preternatural fulness of the parts, there is both a Stiffness and Stupor, which the Patient has commonly the sense of, after the Rheumatick pains are in a manner gone off. Both of them I conceive to be from an alteration in the nature, and consistence of the Mucilage, and the effects particularly of such a Rheumatism as is caused by an Acid. To preserve the Fibres flexible and tensile, it is necessary that they be lubricated and moistened; and for the continual motion and influx of the Spirits into them, it
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is requisite, not only that they be supplied in a sufficient quantity, but their passages, the *Canaliculi* in the Nerves and fibrous parts, must be clear too. Now when the Mucilage is coagulated, it becomes unfit to lubricate the Muscles and Tendons, or to moisten and preserve their Fibres so pliable and tensile as naturally they were. Whereupon they cannot be so easily contracted, nor those parts of them which approach nearer to their Origination when they act, slide so readily, as they ought to do. And there may be some opposition in the Tendons of the Antagonist Muscles, to their own extension, as they must be extended when the others are contracted. I did not long ago, in the tendinous Fibres of a Horse, observe transverse and circular wrinkles or Corrugations, which, if we suppose to be in our own Tendons and muscular Fibres when they are not extended, which we have great reason to do, then we may reasonably think that the coagulated Mucilage, insinuating it self into, and sticking in the small *Foveæ* or Furrows, hinders the free and easy extension of those parts.

So the Stupor, or numbness, which sometimes affects the parts after a Rheumatism, proceeds from the same alteration in the consistence of the Mucilage. For although the obstruction and defect of the Spirits be the
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immediate cause, yet this obstruction arises from such an alteration in the Nature of that Liquor as renders it unfit to perform its office, and to moisten the nervous Fibres; for want of which they will become more dry than they ought to be, and consequently their small Pipes will be contracted: so that this Distemper, where there has been such a Coagulation, leaving sometimes such an alteration in their temper, as contracts and streightens their *Canaliculi* or small Cavities, impedes the plentiful influx of the Spirits into them, and their course thro' them. And where we have such a Stupor, I am apt to think there remains some part of the inspissated Mucilage, after the pains are ceased, and when the swelling in a manner disappears; and that it is thicker, than it is during the height of the Distemper, though, because it has lost that quality which made it dolorosick, it does not affect the Fibres in the same manner as it did before. This angustation of the *Canaliculi* of the Fibres, if it proceeds to a total obstruction, produces a Palsy, as sometimes we do observe that this Distemper succeeds to a Rheumatism.

From what I have said concerning the matter which is often the cause of this Distemper, how it is an Acid, and coagulates the Mucilage, we may understand the reason,

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why a Rheumatism continues sometimes so long and stubborn. And when it is so protracted, I take this to be a true Diagnostick, of the nature of the morbifick Humour.

If I may have leave here to make a little incurfion into the Physicians Province, I would add something concerning the Cure. And from what I have faid of the diverfity of the Humours, which may be the caufe of a Rheumatism, we may difcover fome reafon for altering the means and method of Cure at fome times. And as the difference of the Humour does indicate the ufe of different Medicines, and fhews the unreafonablenefs of one common and conftant method in all, even true and humorofe Rheumatifms, fo by attending to the figns which difcover the quality of the Humour, and whether it has coagulated the Mucilage or not, we may be directed both in our Prognofticks and the choice of Means.

This I may lay down as a general Rule, that fince a Rheumatism, as I have fhewn, is a *Crisis* or depuration of the Blood by the mucilaginous Glands, we muft endeavour to put Nature into another method, and to procure the exclufion of the matter by fome other Glands, which may free, not only the Mafs of Blood, but the whole Body from it ; where it is to be confidered, what excretory
Glands

Glands do seem most apt to separate and carry off that morbidick Matter which is to be excerned. For as there is sometimes a difference in the nature of the matter, so every sort, without doubt, will pass off more readily by one particular way of Evacuation, than by any other.

When the morbidick Humour is acrious, and of such a nature that it does not upon its mixture coagulate nor inspissate the Mucilage, the most convenient Evacuation, after bleeding, seems to be by the cutaneous Glands; and however Diaphoretick Medicines may *malè audire* before the declension of a Rheumatism, yet in this case they may be certainly used, not only with safety, but with benefit; provided they are temperate, and free from an acrimony, such as *Pulvis à Chel. compositus*, *Lapis Contrayervæ*, *Antimonium Diaphoreticum*, a Decoction of *Sarsa*, and things of the like nature.

Besides Evacuation, there must be an endeavour to temper the heat, and to correct the Acrimony: in order whereunto some sorts of Emulsions will be convenient; and this is the case, in which the Tincture of Roses, which is used without any distinction in humorose Rheumatisms, is truly a Specifick: for where the humour is acid, and the Mucilage coagulated, the use of it does seem nei-

ther reconcilable to Reason, nor to be defended against, what Experiments dictate to us. Our Reason will tell us, that Astringents, as Red Roses, are not proper to attenuate; nor an acid, as Oil of Sulphur, or of Vitriol, to prevent or dissolve a *Coagulum*. By experiments we shall find, as I have already shewn, that both Roses, and Oil of Sulphur, or Oil of Vitriol, with which this Tincture is made, do produce the same alteration in the Mucilage that the morbid Matter in this case does induce; so that they cannot be proper means to Cure it, nor effectual Remedies to prevent the farther degrees of the inspissation.

Where the humour is *Saline*, or Briny, though I will not wholly condemn Diaphoreticks, because such a humour seems in some measure apt to be excerned by the cutaneous Glands, as the sweat is naturally salt, yet the most convenient way of Evacuation is by a *Diuresis*: so that as I proposed Diaphoreticks in the first case, so I conceive Diureticks to be most proper in this. For tempering the fixt Salt, it seems reasonable and necessary to dilute it; and in order to correct it, we may allow such light acids as will alter the nature of it in the Blood, and not coagulate the Mucilage, if they proceed so far as to change the nature of that salt humour which is lodged in the Interstices of the Muscles: so
that

that here it is, where the Conserve of *Fructus Cynosbati* seems to be a Specifick. And in this case I do not see, why we may not both with safety and benefit make use of stronger Acids, seeing the fixt Salt and the Acid will mutually alter and correct each other, that the latter may not have a power to coagulate the Mucilage, if it should not only act upon the morbifick Matter in the Mass of Blood, but also find a way into the Interstices of the Muscles by the mucilaginous Glands. What Coral, which is proposed as a Specifick in all humorose Rheumatisms, without such a distinction as I have made, is like to do in this case, I do not well apprehend,

The third and last sort of Humour which I suppose to be most frequently the cause of a Rheumatism, is an Acid; such as not only distends the parts where it is deposited, and affects them with a pain, but likewise makes a considerable alteration in the consistence of the Mucilage. When the Mucilage is thus coagulated, Diaphoretick Medicines are certainly pernicious, not only in the augment and height, but through the whole course of the Distemper; unless it can be first so attenuated, as to be capable of being discharged out of those Cavities in which it is lodged; and the ordinary method of Practice, which forbids the use of them till the declension of it,

is in this case highly reasonable. Though I say, they are at no time proper, unless the inspissated matter be first dissolved and attenuated as a preparatory to the use of such Medicines. However, the effects I found from Spirit of Salt Armoniack, poured upon the coagulated Mucilage, and its contrariety to an Acid, may lead us to the plentiful use of such a Diaphoretick as that is, and of all those things which do in the same manner dissolve a *Coagulum*. When the matter is thick and gelatinous, what can other Diaphoretick Medicines do? suppose they raise a sweat, and drive out some parts of the matter which lies beyond the mucilaginous Glands, we must expect they will be those which are the moist and thin, which are necessary to prevent its induration, and to conspire with our endeavours to attenuate it; by which means we have the coagulated Mucilage reduced to a thicker consistence, and rendered more incapable of being dissipated, and consequently the cure of the Distemper more tedious and difficult. And as I suppose, the more than ordinary toughness, and the very thick consistence of some part of the coagulated Matter remaining, after the pains are gone off, does cause some Symptoms, so I am apt to think that an imprudent use of Diaphoreticks may reduce the matter to that
thick-

thickness, and be the cause of that rigidity and Stupor which are sometimes left behind. There is one thing which may deservedly be recommended, where the morbidick Humour has coagulated the Mucilage, that is, Salt of Tartar; the nature of which we know to be such as will correct an acid; and if Experiments may not be thought to deceive us, will be no less effectual to dissolve the coagulated Mucilage: as appears from the tryals I made with it, which I have given an account of. Here Coral, and testaceous powders may be thought to be proper, and specificks: for tho' it is true, they will not dissolve the *Coagulum*; yet by correcting the Acid in the part affected, they will mitigate the pains, and by altering that part of the morbidick Matter which is not yet excluded from the Mass of Blood, they will cut off that supply which would feed, if I may so speak, and protract the Disease. Some Physicians, for the security of the respiratory Organs, do in the Cure of Rheumatisms prescribe mucilaginous and oily Pectorals, which in this sort of Rheumatism do seem highly reasonable, in respect, not only to the Lungs, but likewise to those muscular parts which are affected: for they standing in need of, and having naturally the supply and benefit of an Oil and a mucilaginous Liquor; and the nature of the Mucilage

being so altered, as to be incapable of answering its intention, this is imitating Nature's Composition, and substituting an artificial mixture, which supplies the defect of that which the morbidick Matter has vitiated.

To this kind of Rheumatism there are some Evacuations, which seem more peculiarly agreeable than any others. By observing the tendency of the Matter to the Salivatory Glands, and the plentiful spitting which some Patients have in this case, I am inclined to think, that a Salivation may here be very proper. And the tough and gelatinous Matter, which I have seen gathered under the *Cuticula*, from the application of Vesicatories to the parts affected; I may say, the sensible relief which I have known from them, has been an Argument to perswade me, that the *Cantharides* are in an especial manner effectual to Evacuate the coagulated Matter.





Of the GOUT.

I Proceed now to consider the other Distemper, the Gout. And if I should be thought to have made a Digression in what I have said of a Rheumatism, I return now to my Argument: for this Disease, as it has its seat amongst the Bones, does plainly lie within the compass of it.

A great part of that account which I have given of a Rheumatism, is applicable to this: the humour which excites the pains, is of the same nature; the Glands by which it is separated from the Mass of Blood, of the same kind; the parts upon which it is cast, equally sensible, and some of them, as the Tendons, which are inserted near the Joints affected, *in Specie* the same: but the seat of it is different; which being in the Joints and about the Tendons that lie near them, changes the name of a Rheumatism, which may be taken for a more general one, for the particular denomination of an *Arthritis*, or Gout. However, since it has a relation to our Bones, and the

the Argument I am concerned with, does direct me to a particular Consideration of it, I shall say something, first of the nature of the Matter which causes it; secondly, I shall explain the manner in which, and the reason why it is carried to and lodged in the parts affected; thirdly, I will endeavour to give the reason of the Symptoms: in all which I shall, as much as ever I can, avoid the repetition of any thing that I have said of the first Distemper.

For the first, the nature of the Humour, I conceive, that there is the same difference which I supposed in a Rheumatism, that it is sometimes Saline and pungent; sometimes acrid and urent; and most frequently an Acid, or in a manner corrosive. I have this to add, that it is certain, it is not always of the same nature from the different, and sometimes contrary effects of the same remedies which we find to be so uncertain and fallacious, that we commonly doubt of the success of one thing in one Patient, which we have found to be efficacious and beneficial to another.

Though there be these differences at some times in the morbidick Matter, yet very commonly the humour seems to be an Acid; and I conclude it to be very often so, not only from what we may observe in many Patients,

tients, about the time when the fit is coming, and whilst it is upon them, as we shall have them complaining of sour belchings, and throwing up acid humours by vomit; but also from the procataretick causes, which frequently give the Patient the first disposition to this Distemper, and afterwards procure the *Paroxysmes* of it, when he adventures to make an Experiment of their effects: these are such Liquors as have much of an acid in them, and do easily degenerate and turn into a sharp Vinegar, as *French Wines*, *Cider*, and the like.

The manner in which the morbidick humour is cast out from the Mass of Blood, when it is thrown into the Interstices of the Joints, and upon the Tendons, which lie near them, is by the way of a *Crisis*. And this makes the Distemper return by *Paroxysmes*; which, when the Mass of Blood is depurated, and the morbidick Matter, which Nature had deposited about the parts affected, is dissipated and spent, go off. But when the Blood comes by degrees, or from some great occasion more suddenly to be again impregnated with such a quantity of these heterogeneous Particles, that the whole Mass is in danger of being depraved, and Nature is irritated to endeavour their exclusion, then they return: there will follow
some

some discharge by those Glands which are most apt to receive and separate them; which in this Distemper being those that supply the Mucilage to the Joints, the morbidick Particles are cast upon these parts, where they raise such Symptoms as are the genuine effects of their own nature, and such as the parts in which they are deposited, are thereupon subject to.

That the morbidick Humour is in this manner, that is critically thrown upon the affected parts, we have reason to conclude from that *Febricula* which immediately precedes the *Paroxysmes* of the Gout, and shews that Nature is then disturbed, and making an attack upon the hostile Matter. And, as when the *Crisis* of an ordinary Fever is once begun, and proceeds by a Sweat, if the sweat be suppress'd, that that *Crisis* is hinder'd, and no other succeeds to it, the Fever is encreased, and all the Symptoms of it often renewed by the retention of the *febrile* Matter in the Mass of Blood: in the same manner will the interruption of this *Crisis* by the mucilaginous Glands of the Joints, or the reflux of the Matter into the Blood, occasion a Fever, if Nature does not find some other way to depurate the sanguineous Mass: as *Forestus* in the 21st Observation of his 29th Book tells us of one who laboured with the *Sciatica*, and upon
making

making a Ligature to open a Vein in his Foot, he fell into a Swoon, so that they could not bleed him; however, he was cured of his pain, but fell into a Fever.

Upon this supposition, that every fit of the Gout is from a critical exclusion of morbidick Particles from the Mass of Blood, and their separation by the mucilaginous Glands, we may apprehend, how the *Paroxysmes* of it may be, as they are commonly esteemed a preservation of the Patient's Life, and a security against violent Fevers and any other more fatal Distempers, as they depurate the Mass of Blood from those *Feculencies*, which, if Nature had not this ready and easy way to cast them out of the sanguineous Mass, would produce such a disorder, and excite such a violent fermentation, as makes a Fever. Upon which Fermentation, if the morbidick Matter happens to be determined to, and thrown upon the Glandules of the more noble parts, then must the consequence be ill, if not fatal; such as an Apoplexy, a *Phthisis*, an *Asthma*, or the like. If the Mass of Blood can never be so victorious as to exclude them by some Glands, there must necessarily follow a *Cochexy*, or ill habit of the whole Body, and all the Mischiefs that attend it. And when does this Distemper prove fatal, but when the Matter is translated

lated to, and fix'd upon some noble Part; or Nature is tired, and so languid that she cannot rise up against her Enemy with so much vigour as to drive it to the extreme parts. Neither do the arthritick *Paroxysmes* only give the Patient some security against other Distempers that might proceed from those impurities which the Blood insensibly contracts; but as the mucilaginous Glands of the Joints are disposed and ready to take off any incongruous Matter, as the Blood has occasion to make use of them, they often prevent those Diseases, which would otherwise arise from evident occasions.

The secretory Organs which serve to this *Crisis*, and separate the morbidick Humour that causes the *Paroxysmes* of the Gout, are *in Specie* the same as those by which the Matter in a Rheumatism flows to the parts affected, that is, the mucilaginous Glands: and I have said so much of them of the Articulations and Tendons, that it is easy to prove they are parts, which by reason of these Glands are evidently obnoxious to the afflux of a preternatural Humour.

Altho' the morbidick Matter is sometimes obtruded upon, and separated by the mucilaginous Glands of some one particular part, yet it is not very strange that the Symptoms will often shift their seat, and that sometimes

very

very suddenly. For tho' Nature will bear some lesser quantity of heterogeneous Particles, and they may lurk in the Mass of Blood for some time, when they have a small beginning, and increase insensibly; yet when they come to that fulness that the whole Mass is in danger of being vitiated, and Nature is irritated to expel them, there arises a fermentation in the Blood, in order to exclude them; which, being once begun, is not easily suppress'd: but if the *Crisis* by the Glands of the Joint, where it is first attempted and begins, be interrupted, then there is a recourse to some other Glands, either of the same kind, as when the Matter is translated from one Joint to another, or to some other mucilaginous Glands; or of a different sort, as when the morbidick Matter is thrown upon the Lungs, the Brain, or Stomach. And how frequent is this motion of the Peccant Humours from some Glands to others in other Cases? How common is it for Nature, in the Evacuation of any morbidick Matter, when she cannot finish her work by the Glands of one part, to command the Service of others? Thus sometimes we shall have a *Diarrhæa* succeed to the stopping of sweats, and the suppression of a *Diarrhæa* excite a kind of Salivation. In the Small Pox, if the *Pustules* fall, and the spitting of the Patient

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unexpectedly stops, how often, and how suddenly does Nature endeavour an excretion of the morbid Matter by the Glands of the Intestines; and sometimes the Kidnies are observed to undertake the work of the cutaneous and salivatory Glands, when the excretion of the various Matter does not proceed well by them?

I take notice of this *Phænomenon*, and have explained the reason of it, to shew that the quick motion of the arthritick pains at some times, and the sudden translation of the Humour do not make it necessary to suppose, that the morbid Matter, or any part of it is immediately supplied from the Nerves, as some would have it to be. Neither do I see how the *Metastasis* of the Matter does in the least favour such a supposition, unless it could be proved that the passage and translation of it is more free and easy by the Nerves, than by the Blood-Vessels. And to make it farther evident, that this observation does not make it improbable, that the Matter is derived from the Mass of Blood in the Gout, let us consider how parallel the case lies between an *Arthritis* and an *Erysipelas*, in this respect where the Matter is generally allowed on all hands to be from the Blood. Does the arthritick humour, when it is repelled, or by any occasion suddenly removed from the part affected,

affected, appear with its Symptoms in some other; sometimes shewing it self in another Joint; sometimes revenging the disturbance upon the more Noble Parts? So in the *Erysipelas* we sometimes observe a translation of the matter as quick and sudden as that in the Gout: and in the same manner it sometimes shews it self again the Glandules of the same nature in some external part; sometimes it is cast upon the Brain, the Stomach, or the Lungs: but yet the arthritick pains are often fix'd and immoveable; and when the matter so suddenly shifts its seat, I take it to be either acrious, or saline, rather than an acid.

From this supposition, that the morbidick Humour is separated by the mucilaginous Glands of the Joints, and the Tendons which lie near them, we may easily satisfy our selves, why the Gout does invade those parts which we find to be obnoxious to it. As for the Sciatica, or Hip-Gout, I have taken notice, that the mucilaginous Gland of the *Acetabulum* of the *Coxendix* is one of the largest of the sort in the whole Body; so that it is no wonder that the Humour is ex-cerned and thrown into the Cavity by it, and excites such Symptoms as we find there. In the Hands, as I have shewn, there not only are considerable Glands in all their Joints; but the Tendons, which are there
S inserted,

inserted, especially those of the *Musculi Perforantes*, have their mucilaginous Glands; so that Nature has a convenience in these parts to depurate the Mass of Blood; and they must receive the morbidick Matter when the Blood in its Circulation obtrudes it upon them, and the Glands are disposed to separate it. The same thing I might observe of the Shoulder and of the Knees. But of all the parts, none are so frequently afflicted with this Disease, as the Feet; and it is plain why they are so. For besides that they have many mucilaginous Glands in their Joints, and others about the Tendons which are inserted into their Bones, as the great Chord, or Tendon of the Muscles, which extend the Foot, and those of the *Perforantes*: I say, besides this, they are the inferior and pendulous parts; so that as their Glands make them capable of entertaining, so their situation does conspire with the effort of Nature, to bring down the morbidick Matter into them.

I should in the next place consider the reason of the Symptoms, which are, an acute Pain, a Tumour, which does most commonly, but not constantly attend the Gout, and the *Tophi*, which are sometimes generated in this Distemper. In the swellings there is nothing so particular and different from them in a Rheumatism, that I need add
any

any thing to what I said concerning them of a Rheumatism. So the sense and Symptom of pain being always found in that Distemper, I have been already obliged to take notice of it; and what I have said concerning it, when it accompanies a Rheumatism, may discover the reason of it here from the nature of the Matter, and so far as it affects the Tendons. But there is one thing here which deserves our consideration, that is, how the Joints themselves, or what parts of them, are affected with the pain. I have supposed the Bones themselves to have some sense, by the mediation of those Fibres which from the *Periosteum* penetrate, and are inserted into their substance; but yet since the extremity of an articulated Bone has no Membrane, I cannot tell how we shall make this part of them capable of Communicating that impression to the sensitive Faculty, which the quality of the morbid Matter is apt to make upon it. There are therefore only the Ligaments, and the Membrane, which lies immediately over the Articulations, with the mucilaginous Glands, that can there be the subjects of it. This, as other Membranes are found to be, may reasonably be thought to be acutely sensible. And if I should say, the Ligaments themselves have some sense, I do not think I should speak either absurdly or

erroneously. I know it is a common opinion that they have none, as being a thing inconsistent with the convenience and well-being of an Animal, and that which would entail an uneasiness and pain upon the motions upon it. But supposing they were sensible, I do not see any necessity to conclude, that their motion, and the stress which is at any time put upon them, would be uneasy and troublesome, so long as that place of the Bone, upon which any part of the Ligament slides, is polished, and continually lubricated with a soft, mucilaginous, and oily substance, and so long as there is no violence offered to them, and they are not extended so as to exceed their bounds prescribed by Nature. Is it not as strange, that the Stomach, which all must acknowledge to be sensible, does daily receive the Nourishment, takes in some matter that is actually hot, as well as some that is cold, and by that matter is distended; yet feels not the ingress of the Food into its Cavity, perceives not the extension of its Fibres, unless there be something offensive in the quality, or some excess in the quantity of what we eat or drink. The reason of which seems to be very much the continual using and accustoming of Nature to the thing. So in the Ligaments, besides the smoothness and lubrication of that part of the Bone which they

they move upon, their being always contiguous to it, and accustomed to slip upon it, makes them unconcerned, and is the reason why they perceive no disorder in their Spirits, tho' they have a sensibility. And it is evident, that the contiguity of a sensible part to that softer substance of the articulated Bones, which is at their extremities, is consistent with the ease of it from the tendinous origination of the *Musculus Biceps* of the Arm, which, in passing from the brim of the *Acetabulum* of the *Scapula*, over the Head of the *Os Humeri*, has no Membrane intervenes between that and the Bone, but is immediately contiguous to it.

When the morbifick Humour is acid, and flows into the Receptacles, as I may call them, of the Mucilage, or Interstices of the Joints, and *Sinuses* of the Tendons, and comes to be mix'd with it, the effect will be the same, or like that which I observ'd in the Experiments I made upon it with *Aqua Fortis*, Spirit of Nitre, &c. that is, a Coagulation, as I have shewn before, when I treated of a Rheumatism. And this may give us the reason, why the Gout not only is often fix'd in one place, but remains so long, and obstinate. For when the matter happens thus to be thick and gelatinous, it is not to be expected that it should be easily and presently dis-

discharged out of the Interstices of the Joints, either by being resorbed, or evaporated, when the consistence of it renders it incapable of insinuating it self into the minute Pores, and penetrating those narrow avenues through which it is to pass. And according to the degree and nature of the acid in the morbidick Humour, it does more or less Coagulate the Mucilage; and the part affected is sooner or later, with more or less difficulty, freed from it, either by the translation of it to another, or by the more happy exclusion of it out of the Body,

As from the *Hypothesis*, by which I have endeavoured to explain the nature and causes of a Rheumatism and Gout, we may be able to solve the reason of all the Symptoms in an ordinary *Arthritis*: so from some of the Experiments which I have given a relation of, it seems to be no difficult thing to account for that tophaceous Matter which is sometimes found concreted in those parts that have been afflicted with this Distemper. I did, then, particularly observe, that an Acid and an Austere, being both mix'd with the Mucilage, did produce a plain, a notable and white Coagulation, where the *Coagulum*, though it was made when the Mucilage was cold, was not so soft and tender, nor dissolvable in water, like that which was made
with

with Acids only : but though it would break, remained distinct in it; and being dried, was easily reducible to a fine powder, like flour, or the fine powder of Chalk. Now therefore I do humbly conceive, that were-ever the Gout comes to be nodose, there is not only an acidity in the preternatural Humour, which is separated by the mucilaginous Glands, and mix'd with the Mucilage; but it is an acid-austere, which is no sooner thrown into the Interstices of the Joints, and the *Sinuses* of the Tendons, which are thereabouts, but it produces a *Coagulum* in Mucilage, and that such a one as is not easily attenuated and dissolved; so that it lies fix'd and imprison'd there, and in time, as the aqueous and moist Particles are by the heat and Spirits carried off, the Terrestrial and Saline parts concentrated come nearer together; and coming to be immediately contiguous, do mutually adhere, and are concreted, so as to produce that Chalk or Tophaceous Matter which is in some arthritick cases to be observed. And as the *Coagulum*, which may be made by an acid-austere, seems apt to make a Concretion of that nature, so the colour of the Tophaceous Matter does answer to that of this Coagulation, so as to seem generated in this manner.

I might here, from some of those Experiments I gave an account of, observe, how proper some preparations from Tartar, Spirit of Salt Armoniack, and those of the like nature, appear to be in a Gout, where the Mucilage is coagulated either with an Acid, or an acid-austere, especially when the *Coagulum* is first made, and before it is plainly Tophaceous. For when it has proceeded thus far, we cannot promise our selves much service from them, when it seems to defy our Art; and Physicians themselves confess, that

Tollere nodosam nescit Medicina Podagram.

And as Medicines of this nature are internally convenient, when the Mucilage is coagulated, so external Remedies of the same nature are certainly reasonable; and none that I know of, seem to carry in them so much efficacy. Therefore I cannot but think, that that which Dr. *Willis* prescribes in his Chapter *de Arthritide*, a Solution of Salt of Tartar, and Salt Armoniack, in Spring or Rain-water, is an excellent fomentation in this case. However, if it be used as it is prescribed, without any distinction and respect to that particular Humour which causes the Gout, and the Coagulation, which it produces, it must necessarily, as the Humour

is

is not always the same, sometimes deceive our expectations, as no remedy will answer them, but when it is opposed to such morbid causes as it is apt to remove.

It is a common Rule and Observation in this Distemper, that the Catharticks, which are used, ought to be very strong, which, especially in case of an Acid and a Coagulation, will hold true. The reason of which will appear, when we consider that the exclusion of the morbid Humour from the Mass of Blood, and the separation which is made by the mucilaginous Glands, is Critical; so that it is requisite they should be sufficient to alter the manner of the *Crisis*, and to turn the Humour into another Channel. But the principal reason seems to be, because the matter to be excerned, is viscous, such as is not apt to be exagitated, nor easily removed out of the Cavity in which it is lodged. But it seems reasonable and necessary, to attenuate the matter both by the internal and external use, of such means as will dissolve a *Coagulum*, before they are exhibited. And if this be first done, perhaps more moderate Purges may be sufficient, and answer our intention more effectually.

The *Hypothesis* of the Great and Immortal Dr. *Willis*, concerning the cause, and *Ratio formalis* of the Gout, is indeed very ingenious;

genious ; but yet, if I may without the suspicion of arrogance discover my dissent from him in this thing, I cannot but say, that as there is no evidence or proof of the accumulation of an Acid from the Nerves, to some *particulæ Salino fixæ* suggested from the Blood, from the congress of which he supposes there arises a fermentation ; so neither could I ever observe by any Experiment such an effervescence as he supposes, when I have at any time poured an Acid to the Mucilage, tho' it was sensibly salt. Neither is it necessary to suppose such an Ebullition or Conflict between the morbidick Particles, to make them painfully injurious to such sensible parts as the Fibres. There is no body will question, but an Acid, an Acrinous, or a Saline Matter, unless it will be conveniently tempered, will without such a commotion, and only by contact, be uneasy to them, and excite such acute pains as we have in this Distemper. Therefore, this supposition, as I conceive, is made, rather to explain the Cause of the *Tophi*, than the reason of the pains : for the Doctor, from the observation of a Coagulation, made by the mixture, and after the effervescence of Spirit of Vitriol with Oil of Tartar, supposes it probable, that from the mixture of an Acid, derived from the Nerves, and of a fixt Salt from the Mass of Blood,

made

made in and about the Joints, there follows first an effervescence; and at length, from various Fermentations and Coagulations of them, there is generated a Tophaceous and chalky Matter. But what I have offer'd with a design to explain the manner how these *Tophi* are produced, seems confirmed by some Experiments, and such as were made with the very Liquor which is actually separated about those parts, and to be found where the Tophaceous Matter is generated, and so comes nearer to a Demonstration.

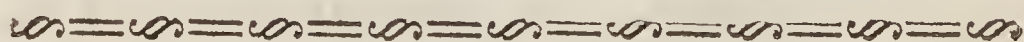
According to that *Hypothesis*, the Matter which is the cause of the Gout, is to be always the same, to wit, an Acid, from the *Genus Nervosum*, and a fixt or *Alchalizate* Salt from the Mass of Blood, which, if it were so, I do not see how there should be such a difference in the effects of the same Remedies: for if there be at no time a difference in the morbidick Matter, that, which is beneficial to one, would as certainly relieve another; and so every one that labours under this Distemper, allowing only for the various degrees of Concretion in the coagulated Matter, which is contradicted by daily experience: so that we must conclude there is such a difference in it as I have supposed, at least, that it is not always of the same nature.

I shall say no more concerning this Subject, only as the nature and effects of some Remedies, which I have known used in the Gout, have agreed with the Notion I have of the Causes and Nature of it, and confirmed me in my Opinion; so I have satisfied myself about the Etiology of their effects, and the manner of their operation from my *Hypothesis*; and perhaps, if it be well consider'd, it may lead us to more rational and effectual means and methods of Cure, than are now made use of: which it is not proper at this time to insist upon, when the design of my Discourses should confine me to Anatomy and natural Philosophy; and every incurfion into the Province of Medicine is a running away from my Argument.





THE FIFTH
DISCOURSE,
 OF THE
 CARTILAGES.



THUS I have pursued the method I at first proposed, as far as the Cartilages, which, tho' I cannot call Bones, yet so nearly are they allied to them, that it is not very strange to find them stepped out of their own form into the *Classis* of Bones; and therefore it will not be improper, tho' the Argument be different, to carry on my Discourses with those Observations I have made of them, and with the account of their Nature. In some Fishes, all the Bones, if I may so

so call them, are no other than Gristles: and there are in Man, the most perfect of all Animals, some of them that continue cartilaginous for some considerable time after the Birth, and are in the ordinary course of Nature converted into Bones. The preternatural mutation of them of the *Aspera Arteria* of the *Cartilago Ensiformis*, and some others, into Bones, is no more than has been observed. So in Horses, Oxen, and some other Beasts, this change is not very rare in the Cartilages of the *Thorax*.

But notwithstanding the aptitude there is in the Cartilages to become Bones, yet the difference, when they are one, and when they are the other, is considerable. First, in their substance, and conformation. The substance of the Cartilages is softer, and the parts of them more easily divided with the Knife; neither have they any large Cavities, as some; nor any spongy part, as all the Bones have. And whereas the Wall, or that which makes the sides of a Bone, is the most solid part of it, I have, in several Cartilages, observed it to be quite contrary, to wit, that the exterior part was the softest and most flexible.

Secondly, They differ in their flexibility. The Bones are rigid, and more tenacious of their figure; the Cartilages are flexible, and
more

more apt to be conformed to those figures, which the force, that bends them, would oblige them to.

The reason of this flexibility in one above the other, is the difference there is as to the union of their Particles, which in a Bone are at their extremities so united in every series, as to form a continued and an entire string, and when all inflexion obliges the extremities of some Particles either to recede, as where the convex is elongated; or to approach nearer to one another, as when the Concave is shortned, consequently that Body, in which they are so united that they can do neither, must be rigid and unapt to be bent.

The flexibility of the Cartilages arises, as in all other Bodies that may be bent without injury, from the position and figure of all, or at least some of their Particles, as well as from the disunion and distinction of their extremities, which are of a long figure, and have a streight position, so that one extremity looks towards one, and the other towards the other end of the Body, which they are the parts of.

Besides the long figure, and the streight position of these Particles, there is a certain order observed in the placing and disposition of them, which is such, that the extremities

ties of those in one Series do not terminate just where the extremities of the Particles which are in the Series next to them, do; but they lie beyond them, and reach to some intermediate part between the extremities of those Particles which lie next to them laterally, as I have express'd in the third Fig. Tab. II. For as the extremities of the Particles in a flexible Body must be distinct, and their figure such, that those which lie in one Series, may be capable of moving and sliding upon them which are contiguous to them in the next; so must their position and order be such, that they may slip, and the extremities of their Particles may not only approach nearer to, but recede from one another, without interrupting the continuity of the Body. For want of the first of which, the Body would be inflexible; and from a deficiency in the other, it would be inevitably broken, upon being bent, when any part of it is elongated. But upon these suppositions we may easily conceive how a flexible Body may be inflected without a dissolution of the continuity of it, even when the convex part is lengthned, and the extremities of the Particles recede one from another. Where they are driven closer together, it is true, there is no reason to think, that a Fracture should

should be the consequence of an Inflexion, though the extremities do not lie in this order. But without doubt, in the bending almost of all Bodies, there is an elongation of one side, even when the other is shortened: and supposing the alteration which is made in the position of their Particles, to be by their recedure, yet still the Body will be as secure against a Fracture, and as capable of being inflected without any injury, whilst the order of its parts is such as I ascribe to them. As suppose in the fourth Fig. Tab. II. *a, a, a, a*, to be four Series of Particles, lying contiguous to one another laterally, and making one Body; suppose those of the first and third Series, which have their termination about the middle part of them which lie next to them in the second and fourth, to be moved, and to slide at one end towards *b*, and in the other part towards *c*, so as to elongate the whole Body, we may apprehend, how they may move both ways, and slip upon the Particles which are laterally contiguous to them, without any injury to the continuity of the whole; and until they come as far as *d*, or the Interstices between the extremities of the Particles in the second and fourth Series, there will be no Fracture. But when they are forced so far, that one of their extremities is brought to those Interstices,

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there

there will necessarily follow a *solutio continui*. And this is the reason why a Body, when it is too much inflected, breaks, and why it is broken first in the convex part; for on that side is the recedure of the extremities of the Particles: and the nearer they lie to the superficies there, the more considerable it is; and consequently they are first brought to the Interstices between the extremities of those Particles which lie next to them laterally.

Not that I suppose, that all the Particles in every flexible Body obtain such a position, or that every one of them, that lie in the same series, are capable of receding from, or moving nearer to one another; but there are so many, that are, as answer to the degree of inflexion, that the Body is capable of *salvâ continuitate*. And according to the number and proportion of the Particles that are of a streight figure, and thus posited; and according to the length of them, and the distance of the extremities of the Particles in one Series, from the extremities of those which are contiguous to them laterally, the Body may be more or less inflected, without a Fracture.

Besides their flexibility, the Cartilages have some rigidity, and a power of restitution or
recoil-

recoiling, when they are bent, which is very evident in the *Epiglottis*, though it be not so rigid as some other Cartilages; which has no Muscles to pull it up, but does, after it has been depress'd by the descending Food, rise by its own innate power of restitution into its natural position; which reflection may be observ'd in it, after the Animal is dead, when it is press'd down upon the *Rimula* of the *Larynx*.

This seems to arise from the Air; sometimes from the pressure of the external Air, sometimes from an *Aer insitus*, included in the Interstices of the Body it self, but generally from both. As I have shewn that it is necessary the extremities of the Particles in a flexible Body should be distinct, so we may reasonably think there are some *Spatiola* or Interstices between them (nay, in many Bodies which are rigid, they are very visible) in which there is an imprisoned Air; which, as it is evident from innumerable Experiments, is endued with an Elasticity or Spring: so that whatever presses upon its Spring, and, as it were, winds it up to an extraordinary height, will cause a sensible renitency in it, and an endeavour to expand it self. And this resistance in the Air, when it is crowded into a narrower space than is convenient to the nature of it, is that which gives a recoiling Body the power

of reflection, and obliges it, after it is bent, to return to its former figure, in which the *Spatiola* within it, obtain their natural capacity, and the Air, which is compress'd, recovers the liberty of expanding it self.

When the concave part of any rigid Body, that is bent, is shortned, and the extremities of the Particles are press'd nearer to one another, the Interstices between them will necessarily be render'd less, and the Air included in them will be compress'd; so that the Spring must be, as is were, wound up, and the natural consequence of this compression will be a renitency in the Air, or an endeavour to drive the Particles into that posture, and the whole Body into that figure that will restore the natural capacity of the Interstices, which was accommodated to the quantity of Air contained in them. The strength and powerful resistance of the aerial Spring, when the Air is contracted into a narrower space than what it usually and naturally expands it self in, is evidently seen in the use of a Wind-Gun; where a greater quantity of Air is crowded into it, than the space, which it is confined to, is capable of containing without a violent compression, and running up the Spring of it to an extraordinary height: and when the Gun is discharged, when the included Air has the liberty of dilating it self,
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and relaxing its Spring, we find with what a force it exerts its elasticity.

But when the convex part of a recoiling Body is elongated; when the extremities of the Particles on that side recede from one another in inflection, the pressure is then not upon the Air, which is included in the Interstices of the Body, but upon the external Air. Forasmuch as the *Spatiola* between the extremities of the Particles are enlarged, so far the Body incroaches upon the Atmosphere, and so long as the external Air is excluded, and has not the liberty of filling up what is added to the capacity of the Interstices, there is nothing to answer for that space which the *Atmosphere* loses; so that the external Air must necessarily be compress'd, and the Spring of it heightned. Thence follows in it an endeavour to drive back the Particles of the inflected Body into their natural position, and to reduce the *Spatiola* of it to their former capacity, which cannot be done without the restitution of the Body to a more streight figure. An effect of this nature from a pressure upon the external Air, we have formerly seen here in an Experiment made by *Monsieur Papin*, before this honourable Society, which was done with the Barrel of a Gun fitted to the Air-Pump. In which Experiment, the Air being exhausted out of the

Gun, and obtruded upon the external Air; and the external Air being excluded from the Cavity of the Barrel, so that it could not obtain any space to answer for that which the evacuated Air then occupied, it was compress'd, and the Spring of it considerably heighten'd; which afterwards appear'd, when the breech of the Barrel was open'd, and the external Air had the liberty of expanding it self: for it rush'd in with that violence, and exerted the power of its Spring so much as to shoot the Bullet, with which the Gun was charged, with a great violence.

I have been the longer insisting upon the nature of flexible Bodies, and made it one part of my business at this time to explain the reason, why those, that have a rigidity, do recoil; not only to shew, why the Cartilages may be bent without breaking, and how they endeavour to return, after they are bent, to their natural figure; but because I designed, that, what I have said concerning the flexibility and power of restitution, which are in some Bodies, should serve as some account of the nature of these parts of the Particles which they consist of, and of the order in which these Particles are disposed. Now therefore, to make a particular application of what I have said of the nature and parts of a flexible and recoiling Body, to the Cartilages;

tilages; the figure of their Particles is long, and they are smooth, their position streight, their extremities distinct; between which there are Interstices, and in these Interstices is an included Air: the Particles are disposed in a certain order, so that in every Series they reach with their extremities to some intermediate part, or near to the middle of those which are next to them laterally, and lie quite over the Interstices, which are form'd between the extremities of those on their sides, whereby the *Spatiola* are inclosed, and the Air contained in them is strictly imprisoned.

From hence we may understand wherein the difference between a Bone and a Cartilage does consist; that in one the Particles are united at their extremities, so that every Series makes a continued and compleat string, whereas in the other they are distinct; and there are little distances or cavities between their ends, so that they are in every series capable of being driven nearer to, or forced farther from one another. And this is the alteration that a Cartilage undergoes when it becomes a Bone, to wit, the Particles at their extremities are so nourish'd, and receive such an addition, as to touch one another there to unite and acquire a continuity; which makes them in every Series form an entire string,

when the implanted Air has a passage out of the Interstices, and gives way to that Nourishment whose accession it did before resist. By this union of the Particles the temper of it is altered; and it being difficult to disengage and part them, it grows firm and inflexible.

The terrestrial parts, and the fixt Salt in the Cartilages, whilst they obtain their proper nature, are much less in proportion to the other parts, than they are in a Bone. For I find there remains after Calcination but about a fifteenth part.

The Cartilages have a Membrane, as the Bones have, which, to speak properly, we must call the *Perichondrium*, though it is in a manner the same, and a continuation of the *Periosteum*; consisting of the same sort of threads, being of the same texture, and every way so agreeing with it, that I need not stand to give a particular account of it. Neither does the use and design of the *Perichondrium* differ from them of the Membrane, which immediately covers the Bones; it serves to cloath the parts, and helps to set bounds to their Accretion: it supplies the want of Nerves in them, gives them a sensibility, and affords them those Spirits which are necessary to assist in their increase; and is a *medium*, whereby the Tendons of the Muscles are fixed to those Cartilages which have
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any of them inserted into them, as those of the *Larynx*, and some others. But in those that are joined to any of the Bones, it seems to be chiefly serviceable in strengthening their conjunction. For tho' there be another contrivance for joining of them, yet when this Membrane is taken off, or divided round that part where they meet, they are easily separated.

For strengthening the adhesion of the *Perichondrium* to the Gristles, and consequently, to make the conjunction of the Bones and Cartilages, which are united, and the union of any part that appertains to them, more firm, they have little Furrows and superficial Pits, or depressions, so to enlarge their superficies, where their Membrane is applied, and adheres to them; which it does partly by an immediate contiguity: which manner of Conjunction, as I observed, when I gave an account of the *Periosteum*, is so much the more firm, as the surface, where two Bodies so united, do immediately touch one another, is larger; and therefore this Membrane has on that side which lies next to the Cartilage, inequalities and protuberances, exactly fitted to, and filling the superficial Cavities, which are formed in the part it adheres to.

But besides this manner of Conjunction, their Membrane is united to them by small *Fibrillæ*, or threads, which enter some way
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into their substance; as those of the *Periosteum* are inserted into the Bones. By these are supplied the Spirits, which serve in their Accretion, and by whose mediation we may reasonably suppose that the Cartilages have some other sense than what is external, and merely in their Membrane.

Though they present us with a whitish colour, they are not destitute of Blood-Vessels, but they have abundance of them; so that in the single *Cartilago Thyroides* I have seen some hundreds of Pores, by some of which some of the Vessels pass'd into it, as by others some of them had their egress. These all serve only for their Accretion and Nutrition.

The Cartilages do not seem to have any medullary Oil separated within them from their Arterial Blood. For though they evidently stand in need of something of that or the like nature, and when I have traced the Blood-Vessels, which run along commonly in the middle of those Cartilages which are of a long figure, so far as the part where I thought they had their termination, I have sometime found an oily substance beyond it; yet I could not discover any Vesicles or Glandules for the separation of it, so that that Oil seemed to be supplied from the Bone to which it was united. Thus in my account
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of the Marrow I supposed some part of the medullary Oil to be assigned to the Cartilages, where they are joined to any Bones; and I observed that there are Pores, which I cannot but think are formed for the communication of it from one to the other.

For the joining of those Cartilages to the Bones, which are united to any of them (besides the service of their Membrane, which I have taken notice of) the Bones are formed in that part which is applied to them with some conspicuous Protuberances, or short and obtuse Roots, and other lesser Radicles, which are numerous, and stand thick together as well in those Protuberances, as in the other parts of that end of the Bones by which they are a little way implanted into the Cartilages.





Of the Use of the CARTILAGES.

THE use of the Cartilages in general, is no obscure thing. We must consider, that there are some parts of the Body, which require a greater strength and solidity than was agreeable with the nature of the Fibres, or Ligaments, as they are necessary for the defence of some tender and noble Parts, or for the Dilatation of some passages, to keep it distended, and to restore it to its natural capacity, when it has been compress'd and streightened; and yet withal, it was no less requisite that they should be more flexible than the Bones, and so pliable as to alter their figure, when the motions and actions of some of the parts which they either protect, or are united, or adjacent to, do require it. Now to make a Part both solid and flexible, and so capable of answering both these intensions, Nature has formed the Cartilages, which are of a middle temper, between a Bone and a Ligament, that partake of the firmness and rigidity of one, and the flexibility of the other; and

and they are made use of wherever a firmer part than a Ligament, and a more pliable substance than a Bone, is required. And it were an easy thing to shew, how all parts of this Constitution are necessary and serviceable in every part where they are planted: but I think it not needful, since every one that does but view and consider the parts which they are appointed to, may have the prospect of them, and the reason of this contrivance at the same time. I shall only give my thoughts particularly concerning the use of the Cartilages, which are united to the true Ribs, because their use, and the manner in which they are serviceable in Respiration, seems to be imperfectly explained, and not truly understood.

Any one may be sensible, how improvident Nature had been, if she had made the Walls of the *Thorax* fibrous, and placed two of the greatest Engines of Life without a solid defence on those sides which are obnoxious to external pressures and injuries. But as these parts were to be protected, so there is the necessary action of Respiration, which, as it was not to be interrupted, nor the parts inservient thereunto to be injured by external violence; so there must be some contrivance, that it may not be hindered by the structure and nature of the

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the parts which inclose the Cavity of the Breast. If the Cartilages of the Breast had been Ligaments, or only membranous, the Heart and Lungs could have had no defence and security against the impressions which the violence, offered to these parts, had been apt to make upon them. If they had been plainly Bones, that Bow which lies between the *Sternum* and the Vertebres, had not been capable of an Elongation; which is certainly the thing designed in making some part of it cartilaginous, that by the reducing of that part to a more streight figure, both the Vertebres and Breast-Bone may be protruded.

The learned and ingenious Dr. *Mayo* has given us a good account, how the Ribs do contribute to the ampliacion of the Breast, by the alteration of their position; and being raised from that Plan which divides the Cavity of the Breast into two equal parts, towards which they did before incline, be it the *Mediastinum*, or be it imaginary; so that whereas before they made acute, they come to form right Angles with that Plan. For the Ribs, as he observes, are not articulated with the Spine and Breast-Bone at right Angles, but so as to form acute Angles beneath themselves: and he supposes the Cartilages are joined to
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them, to add to their length, and for augmenting the Concave of their Arch. And this is demonstrable, that if several Bows, or incurvated Bodies, as the Ribs are, lying upon, or inclining to a Plan, be so raised as to rest upon their extremities, and to make Right Angles with that Plan, they will form a large Cavity under their Arches. But if this were the design of the Cartilages, the Ribs would have done this as well if every one of them had been a continued Bone from the *Sternum* to the Vertebres. Therefore, I conceive, that they are intended to make the Ribs more capable of altering their figure, and so contribute another way to the dilatation of the Breast. I shall not then be affraid to assert, that the Cartilages do some particular way add to the capacity of the Breast in Inspiration, as I doubt not, but they likewise act a part, and assist in the Contraction of it when the Air is forced out of the Lungs.

First, I say, they help in enlarging the Cavity of the *Thorax*, not merely by being raised from the Plan, towards which the Ribs incline when the Air is evacuated; but by altering their figure, when they ascend towards the Clavicles. For if we strictly observe the ampliation of the Breast, when

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we draw in the Air, we shall find that there is something more added to the Capacity of it, than what can proceed from the elevation only of the Ribs: it will appear to any one, that takes notice of it, that the Vertebres of the *Thorax* are driven outwards, and the *Sternum*, though not so sensibly, is protruded, when we inspire; which cannot be effected by the elevation of the Ribs, and their forming Right Angles, with that Plan from which they are raised. For although this does enlarge the Cavity of the Breast in that part which is under their Arches, yet this elevation alone does make no alteration in their Longitude, without which it is impossible they should protrude both those parts that are joined to their extremities, at the same time. For so long as the distance between their extremities is the same when they are pulled up towards the Clavicles, as when they descend, this alteration of their position only can no ways thrust forth the parts which are fixed to their extremities.

Therefore, to solve this thing of the protrusion of the Vertebres and *Sternum* in Inspiration, we must suppose, when the Ribs ascend, such a change of their figure in some part of them, as makes an addition to the length of the whole. And we shall see how this is done, if we observe the figure of the Carti-

Cartilages that are joined to the true Ribs, how it is a sort of an Angle ; so that as this Angle is more or less Obtuse, the extreme part, both of the Rib and Cartilage, recede farther from, or come nearer to one another. So that when the Ribs descend and incline towards their Plan, and their Cartilages obtain their natural figure, this Angle, as it is always obtuse, comes nearer to a Right Angle ; but when they are drawn up, it is rendered more Obtuse. And as the alteration of their figure, when we draw in the Air, and the restitution of it in expiration, require their flexibility, so I have observed these Cartilages to have continued cartilaginous and flexible, where this Angle has been, when the rest of the Cartilage has been of a bony nature ; which confirmed me in my Opinion, that this angular part of them is particularly designed for their elongation, at that time when we inspire. Now this is capable of a Demonstration, that as an Angle becomes more Obtuse, and it approaches nearer to a streight Line, the distance between the extremities of the two lateral Lines, which form it, will be increased. So it is here, the Angle of the Cartilages being rendered more Obtuse by the contraction of the Intercostal Muscles, and they being reduced nearer to streight figure, when the Ribs

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are

are raised, their extremities do necessarily recede from each other, and consequently thrust out the *Sternum* to which they are united at one end, and drive back the Ribs which are joined to the other, by the mediation of which they protrude the Vertebres. And if this were not the design of that angular figure which these Cartilages obtain, to wit, to add to the Capacity of the Breast by the protrusion of those parts, but only to enlarge the Cavity or Arch under the Ribs in their elevation, I do not see why Nature has made this difference between their figure and that of the Ribs, and did not rather give them both the same obliquity, so as to make one exact Bow of them both. Nay, why has Nature made any such thing as Cartilages here, and filled up some part of the distance between the Vertebres and *Sternum* with a substance of a flexible temper, if it were not with this design, to make them capable of an elongation; when, if every Rib had been a continued Bone to the *Sternum*, and had had no such thing as a Cartilage joined to it, it had with an Articulation at the Breast-Bone been as readily disposed to ascend towards the Clavicle, and would have formed the same Arch, as it does with it, if we suppose no alteration in the figure of this part.

I have, secondly, made these Cartilages to conspire in expiration; to prove which, we must consider, that they obtain their proper figure, and their parts have their natural position only, when the Breast is contracted: and because there cannot be such a change in the figure of the Cartilages, as renders their Angle more obtuse than it naturally is, without the same disturbance to their Particles, and the same alteration in their Pores, or the Interstices between the extremities of the Particles, as there are upon the inflexion of any rigid Body, (for what inflexion is to a Body that is streight, the same is extension to that which is crooked) therefore there must necessarily be a pressure upon the Spring, either of an internal included Air, or of the external Air, as the Convex is shortned, or the Concave is elongated: for in the extension or reducing of an oblique Body nearer to a streight figure, different from what it is in the bending of one that is streight, when there is an elongation, it is on the Concave, and the abbreviation is on the Convex part.

These Cartilages, therefore, having from the Spring of the Air a power of restitution, will, when their figure, and the capacity of their Pores are so altered as to make

a pressure upon it, recoyl, and without the help of any Muscles return to their first figure; as we see in the *Epiglottis*, which is not so rigid. By this power of restitution they are one cause of their own, and of the Ribs subsidence, whereby they contract the Cavity of the Breast; and by making a pressure upon the inflated Lungs, contribute to the expiration of the Air which distended them. And this is one great reason why the *Thorax* is contracted in all dead Bodies. This, we cannot think, proceeds from any action of the Muscles, which serve for expiration, unless we will suppose they are always the last that act; which seems to be improbable, when we have better reasons to conclude that the inspiratory Muscles are the last of all these that contract themselves. Let them be which they will, this is certain, that after Death neither of them can modify the Cavity of the Breast, either by contracting or distending of it; whereas, if the Lungs are then inflated, and the *Thorax* is dilated, still it afterwards contracts it self. And though this is partly to be ascribed to the subsidence of the Vesiculous substance of the Lungs, yet, if we consider that the resilience, or reflection of these Cartilages, when they are extended, arising from the elasticity of the Air, without any dependence

dence upon the Animal Spirits, the power of it remains the same when the Body is dead as it was before; and that they have still a natural *conatus* to return to that Figure which they cannot obtain without the depression of the Ribs, and the contraction of the Breast; we cannot but think that this is one thing that determines the posture of the one, the figure and capacity of the other after Death.

F I N I S.





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Fig: 1

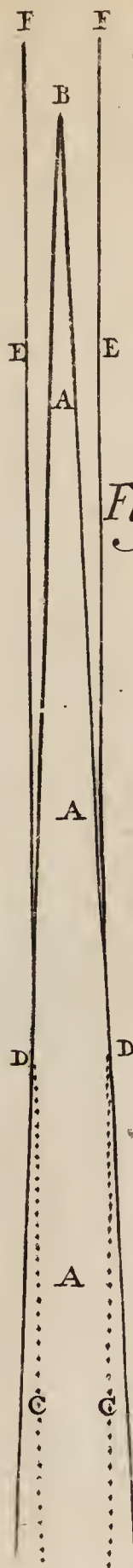
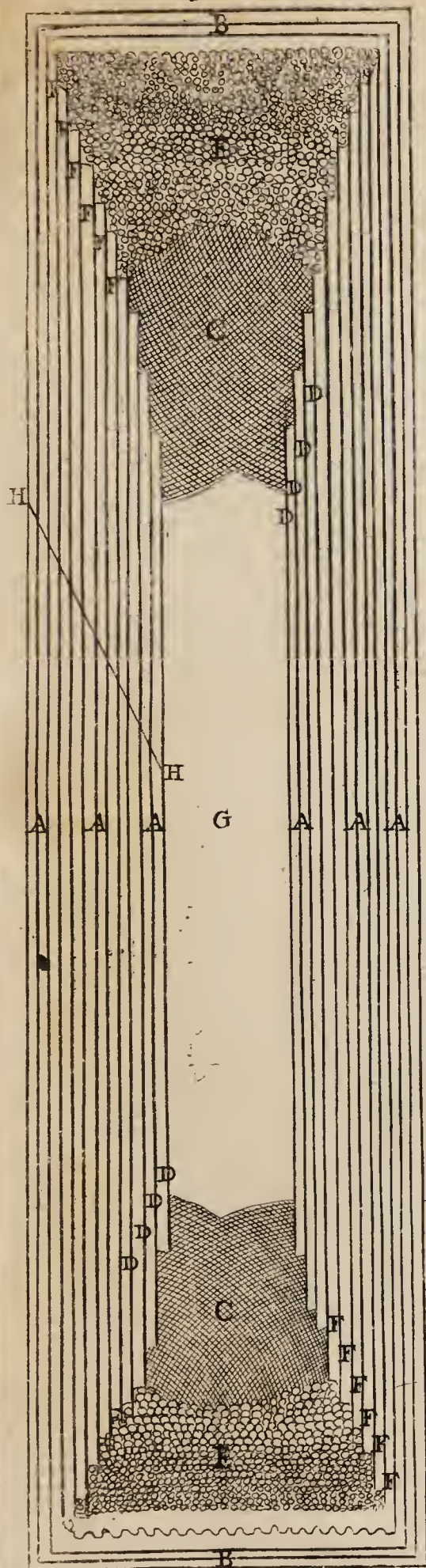


Fig: 2.



Fig: 3.

One of the
Bags of the
Marrow con-
sisting of the
small Vesicles
or Glandules.



TAB:II.

Fig:3.

Represents the Figure of the particles, and the order, in w^{ch} they ly in the Cartilages, and other flexible Bodys, that have a Rigidity.

The Mucilaginous gland, in one of y^e Sinuses of the os Humeri at y^e flexure of the Cubit, taken out of a Human Body

Fig:1.



Fig:4.



Fig:2.

A.A.A.A. The fore part of the Knee taken off.

a.a.a. The large Mucilaginous Glands

b.b.b.b. The Membrane which lyes immediatly over the Interstice of y^e Ioynt.

c. The Patella.

